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# JPRS Report



# Science & Technology

## Europe

FRG: OFFICIAL REPORT ON
MULTIYEAR RESEARCH FUNDING, TRENDS







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# Science & Technology

## Europe

## FRG: Official Report on Multiyear Research Funding, Trends

*JPRS-EST-88-007* | *23 AUGUST 1988*

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### WEST EUROPE

#### SCIENCE & TECHNOLOGY POLICY

# SCIENCE & TECHNOLOGY POLICY

## FRG: Official Report on Multiyear Research Funding, Trends

## Trends in Government Research Policy

### Guidelines

*36980312 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 16-18*

[Excerpts]

**1.2 Guidelines and General Objectives of the Research and Technology Policy of the Federal Government**

**Guidelines and Orientations**

Against the background of the dynamic development of science and technology, research policy must continuously clarify the field of its tasks between the urgent challenges of the times on the one hand and the responsibilities of business and science themselves on the other hand. After the government change in 1982, principles and guidelines were developed within the framework of a reorientation of research policy. These were published in the Federal Research Report of 1984. They have been firmly established and, from a current perspective, can be summarized as follows:

1. The federal government acknowledges freedom of research, especially of fundamental research, the necessity of self-initiative and of the further improvement of basic conditions.

Research which wants to accomplish its task of continuing to open new doors to understanding, must unfold freely and must always be able to follow its inherent logic and its own "internal" insights.

The federal government therefore will continue to apply itself towards conducting a discussion concerning the ethical responsibility of science in a relevant and constructive manner, towards imposing necessary boundaries and regulations on research in a reserved manner and, as much as possible, in agreement with international standards, and towards applying the necessary clarification processes cautiously.

The federal government acknowledges the principle of scientific self- management in basic research. It will therefore strengthen the established institutions of science and of scientific funding, and will help them to develop new impulses, as explained in more details especially in Chapter 4.

These new impulses continue to include the cooperation of scientific institutions with business within the framework of foundation-oriented technological development, as well as the thematic reorientation that has recently occurred in major research institutions.

The special recognition of performance and the challenge to top performance in research, development, and innovation will continue to be a central concern of the federal government. Top performances, the achievement of internationally recognized breakthroughs, and successful work at the vanguard of science are the vital principles and decisive drives for research.

Securing new personnel that is scientifically qualified remains a high priority task for the Federation, the Lands, and business, in view of the age-related personnel fluctuation that is expected to be felt again during the 90's.

2. The subsidiary principle holds for the federal government; it therefore restrains itself with respect to R&D in business.

The relative lag of the state portion of the national R&D budget compared to the business portion is desirable in view of the weight and the dynamics of market-oriented R&D, corresponds to the trend in comparable industrial countries, and is also based on the actual state of affairs. In a market- economy, R&D belong to the original responsibility area of the enterprises. Precisely the modern key technologies with their fast innovation cycles, their intense interaction with scientific progress, require direct in-house and thus financial engagement of the enterprises in the research and not only in the application of scientific results.

This development also corresponds to the emphasis which the federal government places on improving business framework conditions for more growth and employment, for strengthening the power of performance, competition, and private initiative. To further increase the power of performance, competition, and private initiative, the tax system has also been designed so as to be friendly to investment and innovation. This makes an essential contribution within the framework of the 1990 tax reform.

The use of public means for R&D in business therefore basically takes place only where there exists a proper state of responsibility and where R&D requires support for supervening social or economic reasons.

3. The federal government in principle affirms S&T progress as an expansion of the human opportunities for action.

On the other hand, it views as an increasingly important state task the minimization of risks that are inherent in technical progress. As already sketched under 1.1, this task also has an international dimension.

These precautionary motives also substantiate, among other things, the intense engagement of the federal government in environmental research, ecological research, climatological research, research on working

conditions, work organization, and finally health protection in the workplace, health research, and an estimate of the consequences of technology for specialty-oriented processes, as explained in more detail in Chapter 3.

Altogether, it has recently become even clearer that S&T progress is accepted in a democracy if it contributes not only economic advantages but also opens up opportunities for human life, interacts with nature harmoniously, and thus contributes to a further development of our technological culture.

4. The federal government further acknowledges the necessity of opening up long-term perspectives and options for research and for its conceivable technological applications.

In this sense, the following are to be primarily classified as long-term programs:

—Research on nuclear fusion,
—Oceanographic and polar research, and
—Space research.

The long-term programs are characterized especially by:

—a high degree of international cooperation and coordination, which otherwise is reached only in component areas of experimental basic research and —a great need for infrastructure, which can be financed only internationally, especially in the areas of nuclear fusion and space research.

Chapter 3, Section 1.3, as well as Part III of this report, present in more detail the current decisions concerning future European space policy and space research. These decisions indicate that the federal government has recognized the importance of these tasks. Even under the conditions of increasing competition for scarce means, it makes future-oriented and technically appropriate decisions.

5. The federal government will also continue to do everything in its power so that the Federation and the Lands will work together effectively and trustingly in their joint responsibility for research.

Common challenges are, now as before, securing a supply of scientific personnel, a reasonable assignment of priorities, and modern basic equipment in university research, a reasonable balance between scientific self-determination and cooperation with business, and increasing discussion about regional development and research funding.

It is understandable, in view of the more and more clearly emerging significance of R&D for the economic and cultural development of a region, that regional policy should pay special attention to the settlement of research facilities. On the other hand, an overemphasis of regional considerations harbors the risk of fragmentation and of a competitive struggle for scarce research personnel, which could be damaging to research.

The federal government will continue to contribute to a fair equalization of interest within the framework of the established Federal-Land Committees. The federal government will especially encourage promising initiatives from Lands that previously have not been so well equipped with facilities. Nevertheless, as explained in more detail in Chapter 4, the quality and power of the Federal Republic of Germany as a research site remain of central significance also for the collaboration of the Federation and the Lands.

6. The federal government expressly affirms international cooperation in research. Decisive for this are the necessities and opportunities that have already been addressed under 1.1 and that have incidentally also been elucidated in the Federal Research Report of 1984, in particular:

—the opportunities of European collaboration which would strengthen further integration and common competitiveness;

—the opportunities of Atlantic collaboration in future-oriented areas such as space research and technology;

—the world-wide ecological dangers as research tasks that span all boundaries, as well as the necessary collaboration in climatological research;

—dynamic S&T development in key technological areas, which make a necessity of international cooperation in research and in the development of technical norms and standards;

—opportunities to improve the political, economic, and cultural relations with Socialist countries through collaboration in research, and thus to contribute towards mutual understanding and towards a relief of political strains;

—the urgent search for solutions to the existential problems in the Third World, not only for reasons of solidarity, but also for reasons of ecological precaution;

—the necessary securing of the free exchange of scientific ideas, information, and experience, as a basic framework condition of S&T progress, which can be guaranteed only in a spirit of cooperation.

Chapter 2 will provide more detailed explanation concerning the special dynamic development of international cooperation.

## Policies on Basic Research, International Cooperation

*36980312 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 19-29*

[Excerpts]

### Funding of Basic Research

It is one of the advantages of our system of scientific funding that the importance of basic research is undisputed and that, even under strained conditions of the national budget, its financing is altogether held at a higher level or could even be increased. This holds not least of all for funding by the Federation. The Federation funds basic research indirectly and directly, inside and outside the universities.

The main accent here lies primarily on the joint financing of research by the Federation and by the Lands according to the framework agreement on research funding, where primarily the BMBW [Federal Ministry for Education and Science] and the BMFT [Federal Ministry for Research and Technology] participate on the part of the Federation, and specifically:

—in the general funding of university research through the German Research Association;

—in the funding of focal points at the universities, likewise through the German Research Association and through special research areas;

—in the funding of the Max Planck Society;

—in the financing of major research facilities (90 percent Federal portion) with their great need for large scale equipment for basic research and altogether high basic research proportions.

The Federation also furnishes means within the framework of the common task of university construction. These means serve to a considerable extent to support basic research, whether by general improvement of its prerequisites, or whether by furnishing large scale equipment according to the University Construction Funding Law.

To this are added the contributions of the Federation to international institutions of basic research, such as e.g. CERN and ILL (Grenoble).

Especially in the BMFT budget, the funding of basic research has clearly attained greater importance. Its proportion rose from about 28 percent at the beginning of the 80's to about 37 percent in 1987. Relative to federal funding altogether, the proportion of basic research rose from 24.6 percent (1981) to 27.6 percent (1986). Just the BMFT portion of major equipment for basic research, which was decided upon during recent years, amounts to about DM3.5 billion. Beyond this, the portion of basic equipment was clearly increased within the framework of specialty programs. For example, the portion of basic research within the area of funding market-oriented technologies by the BMFT in 1981 was around 4.7 percent, but in 1987 it already reached about 11 percent, and it will continue to rise. Through appropriately designed project funding—including increasing association research—BMFT allocations to the universities have risen from about DM310 million in 1982 to about DM540 million in 1987. Even after the current investment wave for large-scale equipment has been implemented, the proportion of basic research consequently will scarcely fall.

Chapter 4 contains more details concerning the funding of basic research, as do parts II, III and V of this report.

For the coming years, the federal government views as a primary task the still closer linkage of timely, program-oriented basic research with free basically financed research, so that synergy and contact effects become effective for both sides.

### Funding of Market-Oriented Technologies

From 1982 to 1987, the federal government has continuously reduced its direct project funding for business, within the framework of BMFT funding for market-oriented technologies, by an amount of about DM1 billion.

On the other hand, the federal government has concentrated its funding on the development of civil aircraft, on key technologies that overlap several branches, as well as selected areas of energy and transportation technology, and also oceanography. In particular, the following are important:

- Completion of the Airbus family
- Information technology
- Materials research
- Biotechnologies with emphasis on genetic engineering, molecular biology, and renewable raw materials
- Selected physical technologies (among others laser and thin-film technology) with high synergy effects for the already mentioned areas and
- Regenerative energy technologies.

In oceanography, one of the more important points is to contribute towards the development opportunities of coastal regions.

In the BMFT budget, funds for the above areas were increased by 35 percent in 1987 as compared to 1982. Furthermore, the funding was set up methodologically and contextually so that it is increasingly oriented towards basic research and results in a bond between science and business.

Even though the contributions cannot develop further in all areas, as they have in the past, the above named key technologies and market-oriented technologies remain at the center of funding. However, funding is increasingly oriented toward foundation-oriented research by the associations, and thus is rather degressive for business as the receiver.

A strong decline occurred in the allocation of funds for research in nuclear energy technology, primarily because of business participation with considerable means and by streamlined management in the building of the two prototype nuclear power plants THTR 300 and SNR 300. After the THTR 300 has successfully been transferred to the operating company, the federal government expects that the approval procedure under nuclear regulations for the SNR 300 will be continued with renewed speed.

The application of means for research in fossil energy technologies and in transportation research was slightly degressive. Nevertheless—as explained in particular in the technical part (III) of this report—considerable successes could be achieved, especially as regards environmentally friendly power plant and firing techniques, and in connection with coal gasification and liquefaction technology. In transportation research, the further development of the successfully tested Transrapid Magnetic Express Train up to utilization maturity will continue to be emphasized over the next few years.

**Strengthening of Research Areas with Long-Term and International Perspective**

Besides the funding of basic research and urgent tasks of precautionary research, it is a task of research policy also to open up long-term perspectives and options. These include appropriately designed, strategic programs such as nuclear fusion research, oceanographic and polar research, and now especially the new configurations in space research.

Besides the purely research oriented perspectives, the objective here also includes increased integration of Europe and the Western world altogether. Precisely in view of a discussion concerning the advantages and disadvantages of a free flow of know-how, in view of an increasingly more intense technological competition and the burgeoning of protectionist considerations, we need more cooperation, but this cooperation may not impair entrepreneurial competition, even in research. Competition and cooperation together make possible a common realization of future tasks and political coherence.

Both ideas, a far-reaching European independence as an option of research policy, and European and Atlantic cooperation as elements of integration, were the leading ideas of the ESA Council meeting on the Ministerial plane in The Hague in November 1987. In a broad consensus of the European countries, far-reaching basic decisions were reached there concerning independent European space travel and simultaneously concerning trans-Atlantic cooperation. But the possibility was held open for corrections, as these may become necessary.

**Expansion and Intensification of International Collaboration**

Besides the sketched cooperation in space research, further political integration of Europe stands at the center point of considerations when expanding joint European research funding. Important steps in this connection were:

- Adoption of the Single European Act, in which the strengthening of the scientific and technical foundations of European industry and funding of its international competitiveness were emphasized as objectives of the European community;
- Adoption of the new research framework program of the Common Market and
- Successful assimilation of the French-German EUREKA idea.

The successful assimilation of the French-German EUREKA idea has stimulated to an unexpected extent the R&D collaboration of businesses with one another and with research institutions. A remarkable feature here is that this project-related collaboration extends far beyond the member countries of the Common Market, and in particular includes the technologically advanced member countries of the EFTA [European Free Trade Association]. The opportunities of arriving at open European markets in high technology areas have thus been considerably improved.

S&T cooperation research agreements with CEMA countries were reached in 1987. These, on the other hand, underscore the will of the federal government to cooperate beyond the system limits in order to strengthen joint responsibility, to improve understanding, and to expand economic and cultural relations.

Because of the outstanding significance which international cooperation in research and technology has acquired, it will be presented in detail and in context in Chapter 2.

**European Cooperation**

In Europe, the French-German EUREKA idea is on the road to considerable success. The total volume of begun projects currently runs at about DM9 billion. Already at the present time, broad effects and mobilization that were scarcely deemed possible have already been reached, which also includes smaller enterprises. German enterprises participate in 50 projects with a total volume exceeding DM3 billion. Among the 17 new applications for the last EUREKA conference in Madrid in 1987, there already were nine projects for which no state funding is anticipated.

The EUREKA initiative is thus an example of how the joint action of European governments can clear the barriers for business cooperation on both sides, without high administrative expenses being required for this. EUREKA is thematically open to European association projects in market-proximate research, in areas of long-term state programs, and in precautionary research. The EUREKA initiative thus represents an important instrument to achieve the objectives of research and technology policy in the European framework. The federal government consequently will actively support the EUREKA initiative, and will fund EUREKA project proposals with priority.

The research ministry council of the Common Market has adopted a new framework program (1987 - 1991), which offers the opportunity of leading the spirit of cooperation in Europe, which was awakened and promoted by the preceding program, to concrete successes. This involves the solving of a double task, namely on the one hand to select and implement truly strategic projects and, on the other hand, to strengthen European cooperation, that is to stimulate technologically even the previously less developed regions. But the one may not hinder the other; rather the measures provided for in the overall action area of the Common Market must supplement one another.

Now, as before, a coherent work division with the National Research Policies is needed, where primarily the perspectives of early standardization, to accompany the development work, must be taken into account by the organs of the Common Market, in view of the rapid implementation of the common domestic market for high technology goods.

The point here must not be that standards are "forced into harmony" subsequently. Rather, the standard and the market standards must grow as much as possible from the joint work on technology. In view of the dynamic which EUREKA has on the basis of its free and non-bureaucratic cooperation structure, starting from its entrepreneurial initiatives, greater participation from this side is also necessary in Common Market and EUREKA projects, than has been apparent up to now.

Finally, the European countries jointly face the task—in the same way that this is now in progress in the Federal Republic of Germany in connection with major research facilities—of anchoring new and timely task definitions in several institutions of the common research agency. The point here is to utilize available capacities better.

European collaboration in basic research has special significance and a long tradition. Decisions of the federal government such as e.g. concerning participation in the erection of the European synchrotron radiation source in Grenoble or the co-financing of the new high-energy accelerator LEP at CERN, show that the federal government also assigns basic research a high priority in the context of European collaboration. However, it expects that the remaining European countries will also contribute suitably towards the financing of European large scale research equipment, corresponding to the importance of the respective scientific area in their country and corresponding to their economic strength.

The federal government is committed to these common tasks. Within the framework of a common domestic market and of further steps towards the political unification of Europe, it will do everything possible to make the European technological community a reality.

**Strengthening Trans-Atlantic and World-Wide R&D Cooperation**

Even apart from the trans-Atlantic connections in politics, business, and culture, it would also be counterproductive for factual and practical reasons if the European countries were not simultaneously to expand S&T cooperation with the United States and beyond this world-wide:

- About 70 percent of the research potential of the western world lies outside of Europe, more than 50 percent in the United States.
- There is not only intense business interlinkage through high American investments in Europe and vice versa, but intense and fruitful research cooperation at the level of the enterprises and of the enterprises with the universities, as well as of the universities and research institutions.
- Because of the scientific strength of the Unitrd States, cooperation of European enterprises with research institutions and universities in the United States is more significant than the reverse. Nevertheless, collaboration between American firms in Europe and European universities and research institutions is currently developing in a more and more positive manner.

Furthermore, new opportunities are opening up:

- The planned European participation in the international space station under the leadership of the United States can lead to a new quality of S&T relations, and precisely for this reason the European side insists on a fair partnership.
- The costs of major equipment in basic research, for example in high energy physics or within the framework of long-term programs such as nuclear fusion research, are also reinforcing in the United States the idea of a closer partnership with Europe, especially since European capacities in elementary particle physics and outstanding performances in this field offer appropriate attractions.

As regards the United States, the federal government, in common with the rest of Europe, believes that scientific performance should receive the awards due to it. Consequently, the federal government will support efforts for better protection of intellectual property. On the other

hand, the federal government regards science and research—with a few security-based exceptions—as a necessarily open system, to whose creativity all countries should render a suitable contribution.

In this sense, the federal government likewise welcomes the increasing offers of cooperation from Japan and here, too—as with other East Asian countries—strives for a fair partnership which will be useful to both parties. In order to contribute to a deepening of German-Japanese relations, the federal government, together with the MINERVA GmbH (subsidiary of the Max Planck Society) and the Alexander Von Humboldt Foundation, in 1988 set up a humanities and social sciences institute in Japan.

**Expansion of Cooperative Relations with Third World Countries**

As regards the advanced developing countries (emerging countries), we must above all resist the temptation of protection and technological insulation. Only if the industrial countries themselves provide a good example, can the advanced developing countries be stimulated to open their import markets as a precondition for mutual gain.

As regards the other developing countries, well aimed technology transfer and cooperation remain indispensable for building up their own capacities in research and technology. This is true both for reasons of solidarity and in the long term hope for economic self-sufficiency, and also for reasons of ecological providence. Poverty and a lack of technical facilities not only in these countries share the responsibility for threatening ecological catastrophes, especially for the advance of deserts and further deforestation. The damage first strikes these countries themselves, and they are becoming aware of this.

The federal government wants to support the developing countries more in building up their S&T infrastructure, which makes possible the adaptation, development and propagation of technology. The main point here concerns technologies which are adapted to the needs of the developing countries, and which therefore are based on locally available resources and know-how, and which can make a contribution towards improving the living situation of the people—satisfaction of basic needs and increase of self-help potential.

**Utilization of Opportunities for Collaboration with East European States**

The federal government expressly welcomes the recently visible interest of the GDR and the European socialist countries in S&T cooperation with the Federal Republic of Germany. The cooperation agreements concluded in 1987 with the USSR, the GDR, and Hungary open up an opportunity for further positive development. The following points especially favor expansion of S&T cooperation with the CEMA countries:

- Necessity of increasing joint responsibility for ecology and environment, above all with a view to the safety of technical systems, and
- Cooperation beyond the bounds of systems and therefore a possible contribution towards building up good neighborly relations.

On the other hand, S&T collaboration can develop really positively only if confidence is also built up in other fields of political relations. Under these conditions the federal government is ready to contribute towards bridging the "technology gap" feared by many.

## Role of Industry

*36980312 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 43-46*

[Excerpts]

**5.3 Business Increases its own Research Expenditures**

The research dynamics of business has clearly increased. A growing proportion of German research funding is being supplied by business. For 1987, this amount is estimated at DM34.7 billion, which makes up about 61 percent of all research expenditures. This signifies an increase by 57 percent between 1981 and 1987. During the same period, the proportion of state research funding declined to barely 38 percent. Business therefore has intensified its research efforts far above average. Altogether, in 1987 business expended about DM12.6 billion more for R&D than in 1981.

R&D is also carried on mainly in businesses. Nearly 71 percent of all research moneys are actually spent in business. Research projects performed in businesses are largely also financed by them. Thus, the self-financing quota for 1987 is estimated at over 83 percent. Only 15 percent comes from public financing sources. Altogether, the increased dynamics of research expenditures on the part of business manifests the increase of business self-initiative which the federal government desires and encourages.

The IFO Institute for Business Research is also observing increased innovation dynamics in business. The proportion of industries which have implemented innovations has increased from 66.6 percent to 72.7 percent between 1982 and 1986. This development can be observed in all categories of business sizes. Even in small businesses with less than 50 employees, the proportion of businesses who have achieved innovations is 46 percent in 1986 as compared to 37.6 percent in 1982. This clearly shows that businesses of all sizes contribute increasingly to the innovation process. Because of their resources, large enterprises are rather in the position of carrying on basic and precautionary research, of developing complex infrastructure techniques for the public sector, and of converting basic innovations into first-time commercial innovations. Small and medium size enterprises have greater proximity to customers and

therefore participate more strongly in the differentiation of new technologies for various applications and for slots that lie outside the interests of large businesses. Here it appears more and more that technical progress is accelerated by early cooperation of businesses from various branches and various sizes, since this enhances a cross-linking of various technological areas (e.g. machine construction and micro-electronics).

**5.4 Readiness to Promote Cooperation of Science and Business**

In the future, too, the federal government will act towards further stimulating collaboration between science and business. The growing complexity of the inventive process and the concomitant interface problems between the acquisition and commercialization of new technical knowledge underscore the urgency of state engagements. To this must be added the increasing cross-linking of various technological areas (e.g. mechanics, electronics, and sensorics), which overstrains individual businesses, especially on the medium level, and consequently makes cooperation necessary. Consequently, it is becoming more and more important to attenuate the oppositions between short-term market orientation of the businesses and the long-term direction of research, as well as between the need for secrecy and for publicity. There are also many factors in favor of business deciding on industrial locations in terms of a research landscape that is interesting to it and that is ready to cooperate with it.

The readiness of science and business to collaborate will be reinforced by the following measures:

- Further expansion of association research in project funding. This type of funding is less selective and, in suitable cases, causes businesses to participate in the expenditures of research institutions;
- Reinforcing the collaboration between major research institutes and business. With new business-related R&D projects, for example, the interests of the users should be taken into account at an earlier stage and their own participation should be secured where this is appropriate;
- A new concept of contract research, which is even more strongly directed towards collaboration with science.

Furthermore, the following are being tested:

- Continuation of the funding measure "research cooperation between industry and science;"
- Expansion of industrial community research, to further accelerate technology transfer.

**Requirements of Future R&D Research for Small and Medium Enterprises**

R&D funding related to medium-level operations will continue to form a central point of research and technology (compare Part II.9). Besides the already mentioned measures towards more intensive collaboration with science, which is also becoming more and more important to small and medium enterprises (compare Part I.5.4), the federal government will work towards the following objectives:

- The idea "key technology to grasp", i.e. information and consultation in new technological fields which have already been realized in some technical programs of the BMFT, is being developed further for other technological fields. Through technology consultation, demonstration, and the creation of training concepts, such as takes place in trans-enterprise demonstration centers, such as e.g. the CAD/CAM laboratory, rapid spread of new technologies is effected in small and medium size businesses. Demonstration centers also play a role e.g. with the new regenerative energy technologies in information and production engineering, as well as in construction research;
- The quality of the human capital factor in small and medium size businesses should be increased, because qualified personnel represents a decisive precondition for converting research results and for the application of new technologies;
- Indirect, specific funding will be used when there are serious obstacles to diffusion, and financial aid represents a suitable means towards overcoming these obstacles. One must examine whether time limited measures can be used to promote developmental work on in-house application of computer-integrated manufacturing.
- Access to direct project funding is made easier for small and medium size businesses by administrative simplifications. What is anticipated is that costing formulas will be reduced to lump sums;
- The significance of information as a fourth production factor in medium size businesses should be recognized still more. Here, the point will be especially to increase the user-friendliness of information data bases and to stimulate the use of data bases by small and medium size businesses;
- Technology-oriented organizations should be facilitated, so that competition is stimulated. The experience with the BMFT model experiment "technology-oriented business founding" and the bundle of legal measures, which became effective in 1987, to mobilize more risk capital will be evaluated in terms of ways in which more private capital can be activated for technology-oriented new establishments;
- Especially in the trades, which, as users of new technology, are especially confronted by the challenges of structural change, new initiatives should be seized to promote technology transfer—e.g. consultation and demonstration in the Coblenz Metal and Technology Center—and to adapt new technologies to the needs of the trade enterprises.

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## R&D Funding, Personnel Overview

### Summary of Government Funding 1962-87

*36980313 Bonn BUNDESBERICHT FORSCHUNG in German Mar 88 pp 60-64, 351-353*

[Excerpts]

**2. Expenditures for Research and Development**

From 1981 to 1985 (the last year for which data are available), R&D expenditures of the Federal Republic of Germany increased from DM39.3 billion to DM51.6 billion, which is a nominal increase in the "total research budget" of approximately 41 percent for the period covered. This corresponds to an increase in real terms of slightly less than 17 percent (deflated by the price index of the gross national product). Thus, the average annual growth rate in real terms is slightly less than 4 percent.

For 1986, available data indicate R&D expenditures of DM53.5 billion, i.e. an increase of 3.7 percent over 1985. Estimates for 1987 indicate that the research budget of the Federal Republic of Germany will increase by slightly more than 6 percent to approximately DM57 billion.

The major part of the research budget of the Federal Republic of Germany is financed by private industry. Its share continued to increase in the period covered; in 1981, it was 56.1 percent, in 1985 it increased to 60.3 percent. Estimates for 1987 indicate a further increase to 61 percent. The percentages of the other sectors decreased proportionately.

If we disregard the lower percentages for R&D expenditures carried by the individual states in 1983 for reasons of methodology (see table II/2), the share of the federal government and individual states declined in the period covered. This is particularly evident in 1985, a year in which the expenditures of private industry increased more than twice as much as those of the government.

The share of the federal government in the total budget declined from 26.3 percent in 1981 to 24.6 percent in 1985. This trend seems to continue in the two following years. In 1985, the individual state contributed 13.7 percent compared to 14.7 percent in 1983. Here, too, a continued slight decrease is expected. The percentages of private domestic institutions as well as foreign countries changed only insignificantly in the period covered. In 1985, they amounted to 0.3 percent and 1.1 percent respectively; estimates for the following years do not indicate any changes (see Table II/2 and diagram II/3).

If we subdivide the total research budget according to implementing sectors (see Table II/3 and diagram II/4) we see the dominating contribution made by private industry. In 1981, it contributed slightly less than 68 percent to the research budget, for 1985 the figure was 71 percent. According to present estimates, this level will be reached in 1986 and 1987 as well. The increasing share of private industry in carrying out research and development between 1981 and 1985 is contrasted by declining shares of universities and non-university research institutes, with the universities showing a slightly greater decline. From 1981 to 1985, their share decreased from 14.9 percent to 13 percent. An additional slight proportionate decline is expected for 1986 and 1987.

The portion of research and development which is conducted outside the universities by government and private, non-profit institutions (i.e. in research institutions of federal, state, and local governments as well as semi-public and private, non-profit institutions) declined from 14.7 percent in 1981 to 13.2 percent in 1985, with the decline between 1981 and 1983 being partially due to methodology (R&D portions were included in state research institutions;this change had already taken place for federal research institutions). Data available for 1986 and 1987 indicate that non-university research institutions will slightly increase their share in the research budget of the Federal Republic of Germany (see Table II/3).

**Table VII/2: R&D Expenditures of the Federal Republic of Germany and How they are Financed (Total Research Budget)**

| (1) Jahr[1] | FuE-Ausgaben insgesamt (2) | finanziert durch (3) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Gebietskörperschaften[2] (4) | | Wirtschaft[3] (5) | Private inländische Institutionen (PNP)[4] (6) | Inländische Quellen zusammen (7) | | Ausland (8) |
| | Mio DM (9) | | in % des öffentlichen Gesamthaushalts (10) | Mio DM (9) | | Mio DM (9) | in % des BSP 11) | Mio DM (9) |
| 1962 | **4 490** | 2 278 | 2.1 | 2 150 | 62 | **4 490** | 1.3 | – |
| 1963 | **5 380** | 2 627 | 2.2 | 2 670 | 83 | **5 380** | 1.4 | – |
| 1964 | **6 570** | 3 192 | 2.5 | 3 279 | 89 | **6 560** | 1.6 | 10 |
| 1965 | **7 910** | 3 746 | 2.7 | 4 060 | 94 | **7 900** | 1.7 | 10 |
| 1966 | **8 840** | 4 220 | 2.9 | 4 500 | 100 | **8 820** | 1.8 | 20 |
| 1967 | **9 740** | 4 796 | 3.1 | 4 807 | 107 | **9 710** | 2.0 | 30 |
| 1968 | **10 550** | 4 960 | 3.1 | 5 454 | 106 | **10 520** | 2.0 | 30 |
| 1969 | **12 250** | 5 674 | 3.2 | 6 399 | 147 | **12 220** | 2.0 | 30 |
| 1970 | **14 800** | 6 900 | 3.5 | 7 610 | 190 | **14 700** | 2.2 | 100 |
| 1971 | **18 000** | 8 700 | 3.9 | 8 735 | 315 | **17 750** | 2.4 | 250 |
| 1972 | **19 250** | 9 600 | 3.8 | 9 180 | 270 | **19 050** | 2.3 | 200 |
| 1973 | **20 460** | 10 350 | 3.7 | 9 624 | 266 | **20 240** | 2.2 | 220 |
| 1974 | **22 290** | 11 350 | 3.6 | 10 340 | 280 | **21 970** | 2.2 | 320 |
| 1975 | **24 645** | 12 035 | 3.4 | 11 792 | 310 | **24 137** | 2.3 | 508 |
| 1976 | **25 740** | 12 300 | 3.3 | 12 600 | 320 | **25 220** | 2.2 | 520 |
| 1977 | **27 735** | 12 600 | 3.3 | 14 109 | 320 | **27 029** | 2.3 | 706 |
| 1978 | **31 620** | 13 770 | 3.3 | 16 870 | 330 | **30 970** | 2.4 | 650 |
| 1979 | **34 477** | 15 109 | 3.2 | 18 663 | 92 | **33 864** | 2.4 | 613 |
| 1980 | **36 641** | 16 026 | 3.2 | 19 895 | 120 | **36 041** | 2.4 | 600 |
| 1981 | **39 345** | 16 745 | 3.1 | 22 082 | 155 | **38 982** | 2.5 | 363 |
| 1982 | **42 135** | 18 025 | 3.2 | 23 560 | 150 | **41 735** | 2.6 | 400 |
| 1983 | **43 942** | 17 844 | 3.1 | 25 459 | 157 | **43 460** | 2.6 | 482 |
| 1984 | **46 040** | 18 380 | 3.2 | 26 990 | 150 | **45 520** | 2.6 | 520 |
| 1985 | **51 598** | 19 790 | 3.3 | 31 093 | 133 | **51 016** | 2.8 | 583 |
| 1986 | **53 516** | 20 076 | 3.2 | 32 700 | 140 | **52 916** | 2.7 | 600 |
| 1987 | **56 860** | 21 410 | 3.3 | 34 700 | 150 | **56 260** | 2.8 | 600 |

Key:—1.Year [1])—2.Total R&D expenditures—3.Financed by—4.Regional authorities [2])—5.Private industry [3])—6.Private domestic non-profit institutions-PNP [4])—7.Total domestic sources—8.Foreign countries—9.Million DM—10.As a percentage of the total national budget—11.As a percentage of the gross national product

[1]) *Some data are estimates; up to 1985 actual figures; data from 1979 require revision, not fully comparable with previous publications.*

[2]) *Funds for federal research facilities from 1979, for state facilities from 1983, only R&D amounts.*

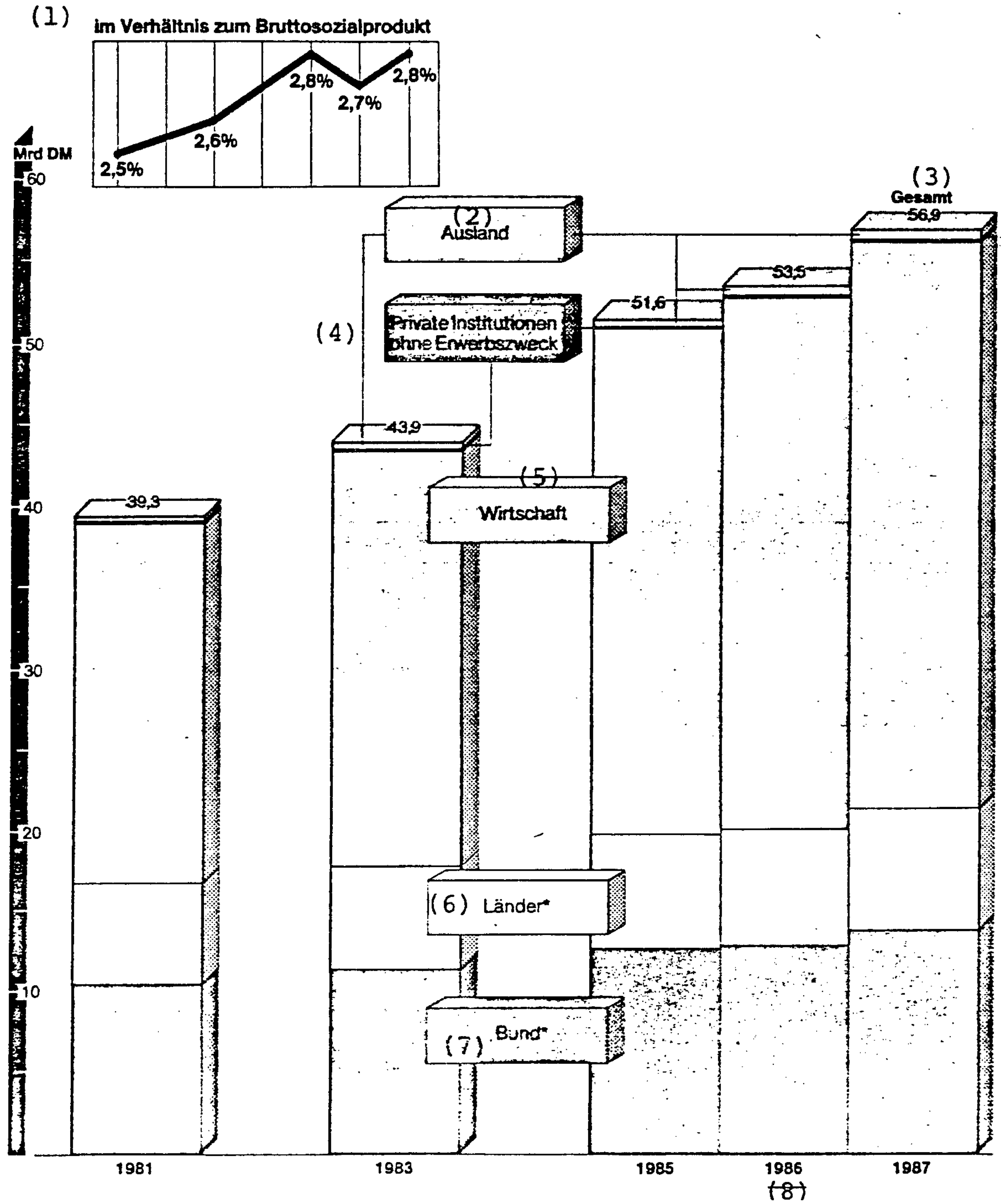
[3]) *Data from surveys of the Professional Association for Scientific Statistics GmbH from 1978, data for R&D personnel cost subsidy program are included (Study Group Industrial Research Associations), adjusted for double counts. Here, R&D expenditures financed by private industry refer to private industry expenditures from capital and earnings as well as private industry funds going to other sectors.*

[4]) *Financed from capital and earnings.*

*Source: Federal Ministry for Research and Technology*

Differences due to rounding

**Diagram II/3 (see Table II/2): Total Research Budget of the Federal Republic of Germany, R&D Expenditures of the Federal Republic of Germany Arranged by Financing Sectors**




Key:—1. As a percentage of gross national product—2. Foreign countries—3. Total—4. Private non-profit institutions—5. Private industry—6. States*—7. Federal government*—8. Estimated

*\) *Research institutions of the federal government, R&D portion only, Research institutes of the individual states from 1983, R&D portion only*

*Source: Federal Ministry for Research and Technology*

**Table VII/3 (Part 1): R&D Expenditures of the Federal Republic of Germany According to Implementing Sectors and How They are Financed (Total Research Budget - in Million DM)**

| (1) Jahr 5) | (2) FuE-Ausgaben insgesamt | (3) Wirtschaft 1) | | | | | (4) Staat 2) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Ausgaben insgesamt (6) | (5) finanziert durch | | | | Ausgaben insgesamt (6) | (5) finanziert durch | | |
| | | | Staat (4) | Wirtschaft (3) | Priv. inl. Inst. (7) | Ausland (8) | | Staat (4) | Wirtschaft und Priv. inl. Inst. (9) | Ausland (8) |
| 1962 | **4 490** | 2 450 | 340 | 2 110 | — | — | 240 | 220 | 20 | — |
| 1963 | **5 380** | 3 030 | 400 | 2 620 | 10 | — | 330 | 310 | 20 | — |
| 1965 | **7 910** | 4 570 | 560 | 3 970 | 30 | 10 | 430 | 400 | 30 | — |
| 1967 | **9 740** | 5 650 | 986 | 4 617 | 17 | 30 | 530 | 500 | 30 | — |
| 1969 | **12 250** | 7 320 | 1 040 | 6 222 | 28 | 30 | 660 | 630 | 30 | — |
| 1971 | **18 000** | 10 700 | 1 950 | 8 464 | 36 | 250 | 890 | 870 | 20 | — |
| 1973 | **20 460** | 12 020 | 2 340 | 9 448 | 15 | 217 | 1 040 | 1 020 | 20 | — |
| 1975 | **24 645** | 14 930 | 2 862 | 11 592 | 12 | 464 | 1 235 | 1 215 | 20 | — |
| 1977 | **27 735** | 17 360 | 2 890 | 13 849 | 15 | 606 | 1 300 | 1 260 | 40 | — |
| 1979 | **34 477** | 23 341 | 4 430 | 18 349 | 48 | 514 | 1 578 | 1 508 | 38 | 31 |
| 1981 | **39 345** | 26 610 | 4 835 | 21 407 | 58 | 311 | 1 709 | 1 565 | 129 | 15 |
| 1983 | **43 942** | 30 462 | 5 255 | 24 702 | 81 | 424 | 1 756 | 1 692 | 47 | 17 |
| 1985 | **51 598** | 36 640 | 5 973 | 30 108 | 55 | 504 | 1 843 | 1 767 | 55 | 21 |
| 1987 | **56 860** | 40 280 | 6 155 | 33 550 | 65 | 510 | 1 860 | 1 777 | 61 | 22 |

Key:—1. Year 5)—2. Total R&D expenditures—3. Private industry 1)—4. Government 2)—5. Financed by—7. Private domestic institutions—8. Foreign countries—9. Private industry and private domestic institutions

**Footnotes to Table VII/3, Parts 1 and 2**

1) *Companies as well as institutions participating in joint industrial research and development (IfG). Data from 1979 are only partially comparable since a larger number of smaller and medium-sized enterprises are covered. Data base: Internal R&D expenditures from surveys of the Study Group Scientific Statistics GmbH (see Table VII/17) including R&D funds provided by the government to private industry which are not completely documented there (1985: approx. DM780 million).*

2) *Federal, state, and local government institutions including scientific museums, libraries and archives; research institutions of the federal government from 1979, of state governments from 1983, R&D portions only.*

3) *Specifically predominantly government-financed scientific institutions (e.g. large-scale research facilities, institutes of the Max Planck Society and the Fraunhofer Society) as well as other non-profit institutions.*

4) *Including international organizations.*

5) *Some of the data are estimates; until 1985 actual data; data from 1979 need revision, only partially comparable with previous publications (in particular for private industry and universities).*

6) *Domestic gross national product (BIP).*

Source: Federal Ministry for Research and Technology

**Table VII/3 (Part 2)**

| (1) Private inländische Institutionen ohne Erwerbszweck 3) | | | | Hochschulen (2) | | | Im Inland durchgeführte FuE zusammen (3) | | Ausland 4) (4) | | | Jahr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (5) finanziert durch | | | (5) | finanziert durch | | | | (5) | finanziert durch | | |
| Aus-gaben ins-gesamt (6) | Staat (7) | Wirt-schaft und Private inl. Inst. (8) | Aus-land (9) | Aus-gaben ins-gesamt (6) | Staat (7) | Wirt-schaft (10) | in Mio DM (11) | in % des BIP 6) (12) | Aus-gaben ins-gesamt (6) | Staat (7) | Wirt-schaft (10) | (11) |
| 700 | 638 | 62 | — | 910 | 900 | 10 | **4 300** | 1.2 | 190 | 180 | 10 | 1962 |
| 750 | 677 | 73 | — | 1 000 | 990 | 10 | **5 110** | 1.3 | 270 | 250 | 20 | 1963 |
| 1 000 | 916 | 84 | — | 1 450 | 1 430 | 20 | **7 450** | 1.6 | 460 | 440 | 20 | 1965 |
| 1 270 | 1 160 | 110 | — | 1 710 | 1 610 | 100 | **9 160** | 1.9 | 580 | 540 | 40 | 1967 |
| 1 310 | 1 154 | 156 | — | 2 250 | 2 200 | 50 | **11 540** | 1.9 | 710 | 650 | 60 | 1969 |
| 2 120 | 1 760 | 360 | — | 3 500 | 3 450 | 50 | **17 210** | 2.3 | 790 | 670 | 120 | 1971 |
| 2 480 | 2 190 | 287 | 3 | 4 270 | 4 200 | 70 | **19 810** | 2.2 | 650 | 600 | 50 | 1973 |
| 2 955 | 2 573 | 338 | 44 | 4 590 | 4 505 | 85 | **23 710** | 2.3 | 935 | 880 | 55 | 1975 |
| 3 115 | 2 704 | 311 | 100 | 5 065 | 4 961 | 104 | **26 840** | 2.2 | 895 | 785 | 110 | 1977 |
| 3 465 | 3 310 | 87 | 68 | 5 154 | 5 044 | 110 | **33 538** | 2.4 | 939 | 816 | 123 | 1979 |
| 4 085 | 3 745 | 303 | 37 | 5 874 | 5 759 | 115 | **38 278** | 2.5 | 1 066 | 841 | 225 | 1981 |
| 4 237 | 4 077 | 119 | 41 | 6 256 | 5 907 | 349 | **42 711** | 2.6 | 1 230 | 912 | 318 | 1983 |
| 4 946 | 4 741 | 147 | 58 | 6 696 | 6 302 | 394 | **50 125** | 2.7 | 1 473 | 1 007 | 466 | 1985 |
| 5 820 | 5 578 | 174 | 68 | 7 110 | 6 660 | 450 | **55 070** | 2.7 | 1 790 | 1 240 | 550 | 1987 |

Key:—1. Private domestic, non-profit institutions 3)—2. Universities—3. Total domestic R&D—4. Foreign countries 4)—5. Financed by—6. Total expenditures—7. Government—8. Private industry and private domestic institutions—9. Foreign countries—10. Private industry—11. in million DM—12. As a percentage of domestic gross national product 6)—13. Differences due to rounding

## Personnel, Government Funding according to Recipients, Topics

*36980313 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 66-80, 356-361*

[Excerpts]

### 3. Personnel Working in Research and Development

The development trends regarding the personnel employed in research and development is just as important a factor for evaluating the research efforts of a country as the development of financial resources.

In 1985, 398,328 persons—full-time equivalents—were employed in R&D in the Federal Republic of Germany. Of these, 36.1 percent (143,627) were researchers, 29.6 percent technical personnel, and others accounted for 34.3 percent (see table VII/29 and diagram II/6). Compared to 1983, the number of R&D personnel increased by a total of 7.9 percent. The researcher category experienced the greatest increase with 9.8 percent, other personnel (+4.7 percent) showed the smallest increase.

Similar to expenditures, private industry employed the largest percentage of R&D personnel. In 1985, R&D personnel in private industry showed an above average increase compared to other sectors, i.e. an increase of 10.3 percent compared to 1983. Researchers account for 34.0 percent of R&D personnel in private industry, technical and other personnel account for 31.4 percent and 34.6 percent respectively (compared to 30.8 percent and 36.3 percent respectively in 1983).

In the other sectors, researchers continue to be the largest R&D category; however, with 42.7 percent, the percentage of university R&D personnel decreased slightly in

1985 compared to 1983; the government sector showed no changes compared to 1983. While in 1985 the percentage of technical personnel in the university sector increased slightly compared to 1983 (to 20.6 percent), it decreased in the government sector; in 1985, it was 32.6 percent. Compared to 1983, the share of other personnel in the university sector increased to 36.7 percent in 1985, and in the government sector to 30.2 percent (see diagram II/6).

**4. Federal Expenditures for Research and Development, 1982 to 1988**

In 1986, federal expenditures for research and development amounted to DM12.8 billion, which corresponds to an increase of 1.0 percent compared to 1985, a year in which the increase in R&D expenditures was above average (an 8.7 percent increase over 1984). Thus, between 1982 and 1986, federal expenditures for research and development increased a total of 11.1 percent, which is an average annual rate of increase of 2.7 percent. For 1987, the federal budget plan has earmarked approximately DM13.8 billion for research and development, which amounts to an increase of 7.7 percent compared to actual 1986 figures; according to the federal budget proposed by the government for 1988, DM13.7 billion will be available for research and development, which would be a slight, .6 percent decrease in expenditures.

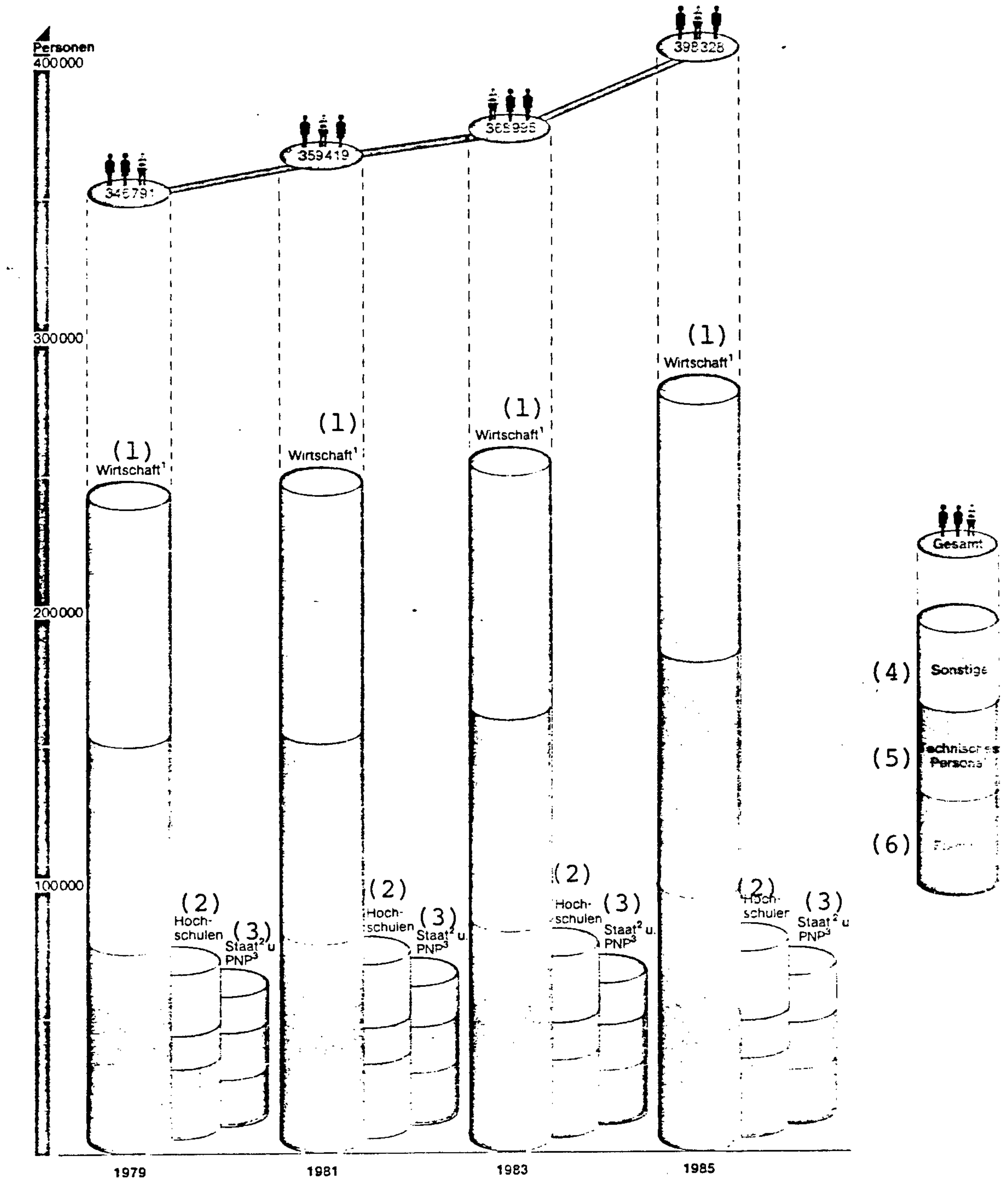
Contributions of the individual departments to the financing of federal R&D expenditures differ widely (see table VII/7). The Federal Ministry for Research and Technology accounts for more than half of the expenditures; in addition, the Federal Ministry for Defense and the Federal Ministries for Education and Science and Economic Affairs have major shares. In the past few years, the four departments mentioned accounted for more than 90 percent of federal expenditures for research and development (see table II/4 and diagram II/7).

Due to the federal R&D performance plan system analysis it has been possible for some years now to list expenditures according to research topics. That is, the individual projects (for the Federal Ministry for Research and Technology) and budget items (for the other departments) are assigned to the subsidized areas and priorities of the system analysis (see table VII/8). Exceptions are expenditures for institutional support for the German Research Society (DFG), the Max-Planck-Society (MPG), and the Fraunhofer-Society (FhG) as well as for the expansion and new construction of universities; all of these are considered to be separate priorities and are combined into one subsidized area. Expenditures for institutional support of large-scale research facilities, however, are distributed among the individual subsidized areas and priorities.

In terms of volume, the subsidized areas "Energy Research and Energy Technology" and "Support Organizations; Expansion and New Construction of Universities" had the largest share in federal non-military expenditures for research and development; in 1986, they accounted for 17.0 percent and 14.3 percent of federal non-military expenditures (see table II/5). According to the projected data for the 1987 budget both percentages will decrease (to 13.7 percent and 13.5 percent respectively), the government proposal for 1988 plans another decrease to 12.5 percent for the energy sector, so that its share in federal, non-military R&D expenditures will be almost cut in half compared to 1985. This is primarily due to a large decrease in expenditures for nuclear energy research, while the funds for renewable energy sources and efficient energy use increased. The third largest subsidized area in terms of volume after the two listed is "Space Research and Space Technology"; in 1986 its share in federal R&D expenditures in real figures amounted to 8.9 percent, in projected 1987 figures it will increase to 10.2 percent; the federal budget proposed by the government for 1988 earmarks another increase to 11.3 percent. Expenditures for the subsidized area "Special Areas of Basic Research" also show an upward trend: in 1986, its share was 8.8 percent, and according to available data, it will be 9.1 percent in 1987 and 1988.

The development of actual expenditures for the individual subsidized areas between 1985 and 1986 varies much more widely than the average increase of federal R&D expenditures would indicate (+1 percent). Few subsidized areas experienced budget cuts; in addition to the energy sector (-22.2 percent), only the subsidized area "Geosciences and Securing of Raw Materials" experienced a substantial reduction in funds. However, several subsidized areas experienced strong increases, in particular "Technical Information" (+37.4 percent), "Information Technology (including Manufacturing Technology)" (+26.2 percent), "Biotechnology" (+21.3 percent) as well as subsidized area "Materials Research; Chemical Process Technology; Physical Technologies" (+12.7 percent). Further, the subsidized areas "Space Research and Space Technology" (+10.5 percent) and "Innovation and Improved General Conditions" (+9.6 percent) experienced considerable increases in expenditures. With regard to actual 1987 data, "Aviation Research and Technology" (+35.3 percent) in particular, and again "Biotechnology" (+24.7 percent), "Space Research and Space Technology" (+22.5 percent), and "Innovation and Improved General Conditions" (+17.5 percent) experienced above-average increases in funds; in addition, in 1987 there are also above-average rates of increase in the civilian subsidized areas "Materials Research; Chemical Process Technology; Physical Technologies" (+13.7 percent), "Research and Development to Promote Health" (+13.1 percent), as well as "Environmental Research, Climate Research; Safety Research" (+11.1 percent) for 1987 (projected figures). The increase in funding for "Military Research and Technology" (+12.0 percent) is also above average in

**Personnel in Research and Development According to Personnel Groups and Sectors*—in Full-time Equivalents—**




Key:—1.Private industry—2.Universities—3.Government ²) and private non-profit organizations ³)—4. Other—5. Technical personnel—6. Researchers

*) As subdivided by OECD

¹) *Excluding social sciences and humanities*

²) *Government institutions including predominantly government-financed scientific non-profit institutions*

³*Private scientific non-profit institutions which are neither predominantly financed by the government nor by private industry (some data are estimates)*

Source: Federal Ministry for Research and Technology

**Table VII/7 (Part 1): Federal Expenditures for Science, Research and Technology according to Topics—in Million DM—**

| (1) Ressort/Einzelplan | 1979 Ist (2) | | 1981 Ist (2) | | 1982 Ist (2) | | 1983 Ist (2) | |
|---|---|---|---|---|---|---|---|---|
| | insgesamt (3) | darunter FuE (4) | insgesamt (3) | darunter FuE (4) | insgesamt (3) | darunter FuE (4) | insgesamt (3) | darunter FuE (4) |
| Bundeskanzleramt . . . . (5) . . . . . | 7,1 | 7,1 | 8,3 | 8,3 | 9,0 | 9,0 | 9,6 | 9,6 |
| Auswärtiges Amt . . . . . (6) . . . . . | 98,5 | 23,7 | 108,3 | 23,6 | 114,3 | 26,3 | 118,8 | 29,1 |
| Bundesminister des Innern [1]) (7) | 173,7 | 84,7 | 206,3 | 99,4 | 224,0 | 103,2 | 224,0 | 102,9 |
| Bundesminister der Justiz . . (8) | 1,6 | 1,6 | 1,9 | 1,9 | 1,9 | 1,9 | 1,7 | 1,7 |
| Bundesminister für Wirtschaft (9) | 927,4 | 775,9 | 1 278,6 | 1 065,5 | 1 259,4 | 1 038,5 | 1 205,5 | 958,2 |
| Bundesminister für Ernährung, Landwirtschaft und Forsten [1]) (10) | 242,9 | 213,3 | 261,7 | 227,8 | 271,9 | 235,6 | 284,9 | 246,5 |
| Bundesminister für Arbeit und Sozialordnung . . . . . . . . . . . (11) | 40,6 | 27,8 | 54,7 | 36,9 | 56,6 | 36,2 | 42,7 | 27,7 |
| Bundesminister für Verkehr (12) | 181,4 | 109,3 | 203,1 | 123,7 | 207,6 | 122,3 | 222,6 | 134,8 |
| Bundesminister der Verteidigung . . . . . . . . . . . . . . . . . . (13) | 2 008,6 | 1 855,8 | 1 700,4 | 1 559,3 | 1 824,7 | 1 695,1 | 1 993,0 | 1 867,9 |
| Bundesminister für Jugend, Familie, Frauen und Gesundheit [1]) (14) | 201,4 | 119,1 | 276,7 | 183,5 | 310,7 | 209,5 | 315,3 | 208,0 |
| Bundesminister für Umwelt, Naturschutz und Reaktorsicherheit [1]) . . . . . . . . . . . . . . . . . . (15) | 146,4 | 126,9 | 135,4 | 114,9 | 153,6 | 132,4 | 176,0 | 151,5 |
| Bundesminister für wirtschaftliche Zusammenarbeit . . . . . (16) | 31,0 | 27,7 | 26,3 | 22,9 | 28,0 | 24,4 | 55,2 | 51,4 |
| Bundesminister für Raumordnung, Bauwesen und Städtebau (17) | 57,2 | 56,9 | 88,6 | 88,2 | 81,9 | 81,3 | 68,9 | 68,2 |
| Bundesminister für innerdeutsche Beziehungen . . . . . . . . (18) | 5,0 | 5,0 | 5,6 | 5,6 | 5,1 | 5,1 | 5,4 | 5,4 |
| Bundesminister für Forschung und Technologie . . . . . . . . . (19) | 5 518,1 | 5 436,4 | 5 957,1 | 5 895,8 | 6 921,8 | 6 865,0 | 6 543,9 | 6 486,4 |
| Bundesminister für Bildung und Wissenschaft . . . . . . . . . . . . (20) | 1 431,8 | 819,1 | 1 481,6 | 881,8 | 1 607,2 | 939,0 | 1 902,8 | 1 009,4 |
| Zivile Verteidigung . . . . . . . (21) | 6,3 | 6,3 | 5,3 | 5,3 | 5,4 | 5,4 | 5,7 | 5,7 |
| Allgemeine Finanzverwaltung . . (22) | 13,7 | 13,7 | 18,3 | 18,3 | 14,4 | 14,4 | 16,6 | 16,6 |
| **Ausgaben insgesamt . . . . . . (23)** | **11 092,7** | **9 710,2** | **11 818,2** | **10 362,5** | **13 097,5** | **11 544,5** | **13 192,7** | **11 380,9** |

Key:—1.Topic/individual plan—2.Actual—3.Total—4.R&D part—5.Federal Chancellor's Office—6.Foreign Office—7.Federal Ministry of the Interior [1])—8.Federal Ministry of Justice—9.Federal Ministry for Economic Affairs—10.Federal Ministry for Food, Agriculture, and Forestry [1])—11.Federal Ministry for Labor and Social Matters—12.Federal Ministry of Transportation—13.Federal Ministry of Defense—14.Federal Ministry for Youth, Family, Women and Health [1])—15.Federal Ministry for the Environment, Protection of Nature and Reactor Safety [1])—16.Federal Ministry for Economic Cooperation—17.Federal Ministry for Regional Planning, Construction and Urban Development—18.Federal Ministry for Intra-German Relations—19.Federal Ministry for Research and Technology—20.Federal Ministry for Education and Science—21.Civil Defense—22.General Finance Authorities—23.Total expenditures

[1]) *For comparison, expenditures for environmental protection, safety of nuclear facilities and radiation protection or of environment and nature which previously came under the responsibility of the Federal Ministry of the Interior, Federal Ministry for Youth, Family, Women and Health and the Federal Ministry for Food, Agriculture and Forestry were transferred to the Federal Ministry for the Environment, Protection of Nature and Reactor Safety.*

Source: Federal Ministry for Research and Technology

Note: Figures in this and the following tables conform to the European decimal notation, i.e. 7,1 million = 7.1 million.

Table VII/7 (Part 2)

| 1984 Ist (2) | | 1985 Ist (2) | | 1986 Ist (2) | | 1987 Soll (1) | | 1988 Reg.-Entw (5) | |
|---|---|---|---|---|---|---|---|---|---|
| ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) |
| 9,7 | 9,7 | 11,8 | 11,8 | 12,9 | 12,9 | 13,6 | 13,6 | 12,1 | 12,1 |
| 118,4 | 29,3 | 125,4 | 31,0 | 125,2 | 31,4 | 130,1 | 33,2 | 134,4 | 34,4 |
| 229,2 | 104,4 | 242,7 | 104,9 | 252,3 | 109,2 | 254,1 | 114,1 | 278,7 | 119,0 |
| 1,9 | 1,9 | 2,1 | 2,1 | 2,1 | 2,1 | 2,5 | 2,5 | 2,5 | 2,5 |
| 1 238,0 | 962,1 | 1 475,5 | 1 174,8 | 1 403,8 | 1 112,7 | 1 519,9 | 1 255,8 | 1 468,7 | 1 093,8 |
| 289,9 | 250,4 | 309,0 | 264,1 | 303,7 | 259,2 | 284,9 | 243,8 | 294,3 | 252,5 |
| 38,6 | 25,3 | 43,5 | 28,2 | 42,7 | 27,0 | 56,0 | 35,7 | 63,5 | 38,7 |
| 206,7 | 128,0 | 217,8 | 134,8 | 213,5 | 127,6 | 221,2 | 129,3 | 236,8 | 140,1 |
| 2 096,0 | 1 985,6 | 2 617,1 | 2 499,4 | 2 669,4 | 2 534,1 | 2 968,0 | 2 833,8 | 2 934,3 | 2 798,5 |
| 297,0 | 184,3 | 328,9 | 196,9 | 339,6 | 180,6 | 387,0 | 194,0 | 428,8 | 217,2 |
| 182,1 | 156,8 | 187,6 | 161,7 | 197,3 | 170,3 | 221,5 | 190,7 | 207,1 | 173,4 |
| 49,5 | 45,7 | 55,8 | 52,0 | 56,3 | 52,6 | 60,2 | 55,7 | 60,1 | 56,2 |
| 66,5 | 65,9 | 68,3 | 67,7 | 80,1 | 79,4 | 56,3 | 55,6 | 50,4 | 49,7 |
| 5,7 | 5,7 | 7,1 | 7,1 | 8,2 | 8,2 | 8,7 | 8,7 | 8,9 | 8,9 |
| 6 748,7 | 6 683,0 | 7 029,9 | 6 953,9 | 7 142,2 | 7 065,4 | 7 677,9 | 7 576,2 | 7 719,7 | 7 616,1 |
| 1 889,2 | 1 016,3 | 1 744,5 | 987,8 | 1 871,1 | 1 031,7 | 1 798,8 | 1 042,1 | 1 791,6 | 1 053,6 |
| 5,8 | 5,8 | 5,7 | 5,7 | 6,0 | 6,0 | 8,1 | 8,1 | 8,3 | 8,3 |
| 19,7 | 19,7 | 17,3 | 17,3 | 15,7 | 15,7 | 20,9 | 20,9 | 55,1 | 55,1 |
| **13 492,5** | **11 679,9** | **14 490,2** | **12 701,2** | **14 742,2** | **12 826,3** | **15 689,7** | **13 813,7** | **15 755,4** | **13 730,2** |

(6) Rundungsdifferenzen

Key:—1.1987 projected—2.Actual—3.Total—4.R&D part—5.1988 government proposal—6.Differences due to rounding

1987 (projected). Looking at the development in expenditures envisioned by the federal budget proposal for 1988, there are great increases in funds for the subsidized areas "Geosciences and Securing of Raw Materials" (+22.4 percent), "Research and Development to Promote Health" (+12.6 percent); "Materials Research; Chemical Process Technology; Physical Technologies" (+12.0 percent), as well as "Space Research and Space Technology" (+10.4 percent), and "Biotechnology" (+7.9 percent). The subsidized area "Innovation and Improved General Conditions" is expected to experience a great reduction in funds 9-34.0 percent ) primarily due to abolition of the R&D personnel cost subsidy program. Decreases in planned budged expenditures for 1988 can als be expected for "Energy Research and Energy Technology" (-9.2 percent), "Information Technology" (-6.5 percent), and "Research and Technology for Ground Transport and Traffic" (-5.7 percent) (see table II/5).

Looking only at the R&D expenditures of the Federal Ministry for Research and Technology (see table II/6), the development in the individual subsidized areas is similar. In addition, the above-average increase in expenditures between 1985 and 1986 in the area of "Liberal Arts; Economics and Social Sciences" (+17.7 percent) and in the health field (+7.7 percent) should be emphasized. This upward trend continues according to projected data for 1987.

### 5. Basic Research Portion of Federal Research Support

In the past few years, federal expenditures for basic research showed an above-average increase; the annual rates of increase were between 5 percent and 10 percent. While federal R&D expenditures between 1981 and 1986 (for these years, only actual figures are available) increased by slightly less than 25 percent, the increase in funds for basic research for the period covered amounted to over 38 percent percent (see table II/10).

In 1986, basic research accounted for 27.5 percent of federal R&D expenditures, in 1985, it had been 26.3 percent. However, when evaluating the development of the basic research portion, one has to take into account that over time it is subject to "natural" fluctuations which are caused in particular by the effect of large-scale projects and related investment costs which are frequently necessary.

Table II/11 shows how basic research is distributed among the various subsidized areas. As can be seen, the subsidized areas "Special Topics of Basic Research" and "Support Organziations; Expansion and New Construction of Universities" must be counted almost exclusively among basic research. The subsidized areas "Oceanography and Oceanographic Technology; Polar Research" (60.4 percent), "Research and Development to Promote Health (40.6 percent), "Space Research and Space Technology (40.1 percent), as well as "Biotechnology" (39.5 percent) should be mentioned because their share in basic research is far above average. If we look only at non-military subsidized areas, the share of basic research increases to 34.2 percent, i.e. more than a third of R&D expenditures are assigned to basic research. (For the share of basic research in the R&D expenditures of the Federal Ministry for Research and Technology see table II/8).

**Table VII/8 (Part 1): Federal Expenditures for Science, Research and Development According to Subsidized Areas and Priorities —in million DM—**

| (1) Förderbereich Förderschwerpunkt | 1979 Ist (2) | | 1981 Ist (2) | | 1982 Ist (2) | | 1983 Ist (2) | |
|---|---|---|---|---|---|---|---|---|
| | insgesamt (3) | darunter FuE (4) | insgesamt (3) | darunter FuE (4) | insgesamt (3) | darunter FuE (4) | insgesamt (3) | darunter FuE (4) |
| **A Trägerorganisationen; Aus- und Neubau von Hochschulen** | **1 778,4** | **1 060,2** | **1 887,4** | **1 183,8** | **1 028,6** | **1 263,5** | **2 368,5** | **1 372,5** |
| A 1 Grundfinanzierung MPG | 318,7 | 318,7 | 353,5 | 353,5 | 361,5 | 361,5 | 370,1 | 370,1 |
| A 2 Grundfinanzierung DFG | 400,4 | 400,4 | 474,1 | 474,1 | 505,2 | 505,2 | 500,9 | 500,9 |
| A 3 Grundfinanzierung FhG | 60,8 | 60,8 | 83,0 | 83,0 | 95,6 | 95,6 | 101,3 | 101,3 |
| A 5 Aus- und Neubau von Hochschulen[1]) | 998,5 | 280,3 | 976,8 | 273,3 | 1 066,4 | 301,3 | 1 396,1 | 400,2 |
| **B Sonderbereiche der Grundlagenforschung (insbesondere Großgeräte)** | **545,7** | **545,7** | **601,4** | **601,4** | **639,2** | **639,2** | **686,8** | **686,8** |
| **C Meeresforschung und Meerestechnik; Polarforschung** | **130,5** | **130,5** | **260,8** | **260,8** | **212,5** | **212,5** | **171,8** | **171,8** |
| C 1 Meeresforschung | 50,9 | 50,9 | 50,4 | 50,4 | 46,0 | 46,0 | 37,9 | 37,9 |
| C 2 Meerestechnik | 71,9 | 71,9 | 103,5 | 103,5 | 76,0 | 76,0 | 86,4 | 86,4 |
| C 3 Polarforschung | 7,6 | 7,6 | 106,9 | 106,9 | 90,6 | 90,6 | 47,5 | 47,5 |
| **D Weltraumforschung und Weltraumtechnik** | **637,4** | **637,4** | **662,3** | **662,3** | **695,7** | **695,5** | **710,3** | **710,3** |
| **E Energieforschung und Energietechnologie** | **1 957,6** | **1 909,5** | **2 096,7** | **2 070,1** | **2 868,2** | **2 850,8** | **2 452,7** | **2 434,7** |
| E 1 Kohle und andere fossile Energieträger | 393,9 | 393,9 | 436,6 | 436,6 | 493,4 | 493,4 | 361,4 | 361,4 |
| E 2 Erneuerbare Energiequellen und rationelle Energieverwendung | 189,5 | 189,5 | 258,1 | 258,1 | 297,4 | 297,4 | 244,7 | 244,7 |
| E 3 Nukleare Energieforschung (einschl. Reaktorsicherheit) | 1 273,6 | 1 225,5 | 1 297,0 | 1 270,4 | 1 960,6 | 1 943,2 | 1 703,8 | 1 685,8 |
| E 4 Kernfusionsforschung | 100,6 | 100,6 | 105,0 | 105,0 | 116,7 | 116,7 | 142,7 | 142,7 |
| **F Umweltforschung; Klimaforschung; Sicherheitsforschung** | **469,0** | **418,6** | **503,0** | **442,4** | **521,8** | **458,4** | **535,4** | **464,3** |
| F 1 Ökologische Forschung | 167,1 | 143,7 | 186,3 | 160,5 | 202,8 | 175,4 | 207,3 | 177,0 |
| F 2 Umweltschonende und Umweltschutztechnologien | 174,7 | 167,2 | 150,6 | 142,7 | 143,0 | 134,8 | 149,9 | 140,4 |
| F 5 Wasserforschung | 49,3 | 46,2 | 62,9 | 59,4 | 58,2 | 54,2 | 47,8 | 44,2 |
| F 7 Klimaforschung | 6,2 | 6,2 | 5,5 | 5,5 | 9,5 | 9,5 | 13,5 | 13,5 |
| F 8 Sicherheitsforschung und Sicherheitstechnik | 71,7 | 55,3 | 97,6 | 74,3 | 108,4 | 84,6 | 117,0 | 89,3 |
| **G Forschung und Entwicklung im Dienste der Gesundheit** | **317,3** | **259,4** | **406,1** | **340,3** | **427,0** | **355,4** | **435,8** | **359,6** |
| **H Forschung und Entwicklung zur Humanisierung des Arbeitslebens** | **119,3** | **106,5** | **142,1** | **124,3** | **151,8** | **131,4** | **128,1** | **113,1** |
| **I Informationstechnik (einschl. Fertigungstechnik)** | **497,8** | **497,4** | **375,4** | **375,1** | **492,5** | **492,3** | **541,9** | **541,6** |
| I 1 Informationsverarbeitung | 271,5 | 271,1 | 133,3 | 133,0 | 115,9 | 115,6 | 108,2 | 107,9 |
| I 2 Technische Kommunikation | 73,9 | 73,9 | 74,6 | 74,6 | 103,4 | 103,4 | 100,4 | 100,4 |
| I 3 Elektronische Bauelemente | 99,6 | 99,6 | 109,1 | 109,1 | 121,1 | 121,1 | 123,5 | 123,5 |
| I 4 Anwendung der Mikroelektronik; Mikroperipherik | 12,7 | 12,7 | 17,7 | 17,7 | 106,1 | 106,1 | 169,8 | 169,8 |
| I 5 Fertigungstechnik | 40,0 | 40,0 | 40,7 | 40,7 | 46,1 | 46,1 | 40,0 | 40,0 |
| **K Biotechnologie** | **89,3** | **89,3** | **93,7** | **93,7** | **108,8** | **108,8** | **124,3** | **124,3** |

Key:—1.Subsidized area/priority—2.Actual—3.Total—4.R&D part—A=Carrier organizations: Expansion and new construction of universities—A1=Basic financing of MPG—A2=Basic financing of DFG—A3=Basic financing of FhG—A5=Expansion and new construction of universities [1])—B=Special areas of basic research (in particular large machines)—C=Oceanography and oceanographic technology; polar research—C1=Oceanography—C2=Oceanographic technology—C3=Polar research—D=Space research and space technology—E=Energy research and energy technology—E1=Coal and other fossil energy sources—E2=Renewable energy sources and efficient energy use—E3=Nuclear energy research (incl. reactor safety)—E4=Nuclear fusion research—F=Environmental research; climate research; safety research—F1=Ecology research—F2=Technologies for environment preservation and protection—F5=Water research—F7=Climate research—F8=Safety research and safety technology—G=Research and development to promote health—H=Research and development to humanize the worklife—I=Information technology (incl. manufacturing technology)—I1=Information processing—I2=Technical communication—I3=Electronic components—I4=Application of microelectronics; microperipherals—I5=Manufacturing technology—K=Biotechnology
[1]) *Including German Federal Armed Forces academies and federal technical schools for public administration.*

## Table VII/8 (Part 2)

| 1984 Ist (2) | | 1985 Ist (2) | | 1986 Ist (2) | | 1987 Soll (1) | | 1988 Reg.-Entw. (5) | |
|---|---|---|---|---|---|---|---|---|---|
| ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) |
| **2 378,3** | **1 418,2** | **2 255,4** | **1 402,8** | **2 422,6** | **1 472,2** | **2 349,0** | **1 482,9** | **2 375,2** | **1 517,6** |
| 392,7 | 392,7 | 405,1 | 405,1 | 420,4 | 420,4 | 430,3 | 430,3 | 442,8 | 442,8 |
| 526,5 | 526,5 | 541,8 | 541,8 | 546,8 | 546,8 | 574,6 | 574,6 | 595,2 | 595,2 |
| 111,6 | 111,6 | 116,3 | 116,3 | 126,4 | 126,4 | 135,7 | 135,7 | 145,9 | 145,9 |
| 1 347,6 | 387,4 | 1 192,3 | 339,7 | 1 329,0 | 378,6 | 1 208,4 | 342,3 | 1 191,4 | 333,8 |
| **760,6** | **760,6** | **850,6** | **850,6** | **911,0** | **911,0** | **996,2** | **996,2** | **1001,0** | **1 001,0** |
| **226,0** | **226,0** | **226,3** | **226,3** | **235,8** | **235,8** | **234,6** | **234,6** | **246,7** | **246,7** |
| 74,0 | 74,0 | 82,3 | 82,3 | 89,1 | 89,1 | 84,1 | 84,1 | 90,4 | 90,4 |
| 82,2 | 82,2 | 81,9 | 81,9 | 85,5 | 85,5 | 88,1 | 88,1 | 94,4 | 94,4 |
| 69,8 | 69,8 | 62,0 | 62,0 | 61,2 | 61,2 | 62,4 | 62,4 | 62,0 | 62,0 |
| **775,1** | **775,1** | **830,5** | **830,5** | **917,6** | **917,6** | **1 124,2** | **1 124,2** | **1 241,4** | **1 241,4** |
| **2 345,4** | **2 324,8** | **2 274,9** | **2 250,3** | **1 773,9** | **1 750,3** | **1 553,0** | **1 506,4** | **1 417,8** | **1 367,4** |
| 353,8 | 353,8 | 307,8 | 307,8 | 280,3 | 280,3 | 234,5 | 234,5 | 211,1 | 211,1 |
| 220,9 | 220,9 | 209,9 | 209,9 | 181,5 | 181,5 | 233,2 | 233,2 | 241,5 | 241,5 |
| 1 612,9 | 1 592,4 | 1 589,8 | 1 565,2 | 1 113,8 | 1 090,2 | 885,3 | 838,7 | 764,3 | 713,9 |
| 157,8 | 157,8 | 167,4 | 167,4 | 198,2 | 198,2 | 199,9 | 199,9 | 200,9 | 200,9 |
| **587,7** | **511,6** | **669,0** | **586,5** | **690,0** | **607,2** | **760,6** | **674,6** | **809,2** | **701,4** |
| 219,1 | 188,8 | 259,7 | 228,2 | 278,6 | 245,9 | 308,2 | 271,6 | 322,4 | 283,5 |
| 169,3 | 159,6 | 184,0 | 174,0 | 190,3 | 179,8 | 217,6 | 205,6 | 209,8 | 196,5 |
| 54,9 | 50,8 | 61,0 | 56,0 | 52,3 | 47,6 | 53,9 | 49,6 | 50,7 | 45,9 |
| 18,5 | 18,5 | 27,3 | 27,3 | 31,2 | 31,2 | 42,7 | 42,7 | 44,1 | 44,1 |
| 125,9 | 93,9 | 137,0 | 101,0 | 137,6 | 102,7 | 138,2 | 105,1 | 182,3 | 131,2 |
| **436,2** | **354,5** | **475,9** | **376,4** | **495,3** | **369,9** | **576,3** | **418,5** | **648,4** | **471,4** |
| **114,1** | **100,9** | **132,2** | **116,9** | **139,7** | **124,0** | **157,7** | **137,3** | **165,1** | **140,4** |
| **583,2** | **583,0** | **623,8** | **623,8** | **787,4** | **787,3** | **855,2** | **854,9** | **799,3** | **799,0** |
| 110,1 | 109,9 | 151,5 | 151,5 | 185,5 | 185,5 | 223,1 | 222,8 | 232,6 | 232,3 |
| 129,4 | 129,4 | 104,1 | 104,1 | 140,9 | 140,9 | 156,6 | 156,6 | 150,7 | 150,7 |
| 127,8 | 127,8 | 167,7 | 167,7 | 239,4 | 239,4 | 234,6 | 234,6 | 224,6 | 224,6 |
| 145,0 | 145,0 | 58,9 | 58,9 | 65,4 | 65,4 | 80,0 | 80,0 | 73,6 | 73,6 |
| 70,9 | 70,9 | 141,7 | 141,7 | 156,2 | 156,2 | 161,0 | 161,0 | 117,8 | 117,8 |
| **127,8** | **127,8** | **146,7** | **146,7** | **177,9** | **177,9** | **221,8** | **221,8** | **239,3** | **239,3** |

Key:—1.Projected—2.Actual—3.Total—4.R&D part—5.1988 government proposal

## Table VII/8 (Part 3)

| (1) Förderbereich Förderschwerpunkt | 1979 Ist (2) | | 1981 Ist (2) | | 1982 Ist (2) | | 1983 Ist (2) | |
|---|---|---|---|---|---|---|---|---|
| | insgesamt | darunter FuE | insgesamt | darunter FuE | insgesamt | darunter FuE | insgesamt | darunter FuE |
| | (3) | (4) | (3) | (4) | (3) | (4) | (3) | (4) |
| **L Materialforschung; chemische Verfahrenstechnik; physikalische Technologien** | **311,8** | **254,2** | **377,1** | **297,0** | **386,3** | **305,4** | **410,5** | **319,8** |
| L 1 Materialforschung | 126,3 | 97,0 | 161,4 | 122,7 | 178,8 | 141,0 | 204,8 | 166,6 |
| L 2 Chemische Verfahrenstechnik | 35,9 | 35,9 | 33,3 | 33,3 | 28,6 | 28,6 | 24,0 | 24,0 |
| L 3 Physikalische Technologien | 149,6 | 121,2 | 182,4 | 141,0 | 178,9 | 135,9 | 181,7 | 129,2 |
| **M Luftfahrtforschung und -entwicklung** | **262,7** | **262,7** | **477,9** | **477,9** | **428,7** | **428,7** | **365,2** | **365,2** |
| **N Forschung und Technologie für bodengebundenen Transport und Verkehr (einschl. Verkehrssicherheit)** | **340,9** | **294,9** | **337,2** | **294,7** | **347,4** | **298,3** | **311,7** | **260,6** |
| **O Geowissenschaften und Rohstoffsicherung** | **170,0** | **127,8** | **224,8** | **167,1** | **213,2** | **152,0** | **209,9** | **149,9** |
| O 1 Geowissenschaften (insbesondere Tiefbohrungen) | 67,7 | 40,7 | 90,8 | 53,8 | 94,2 | 56,2 | 95,6 | 57,8 |
| O 2 Rohstoffsicherung | 102,3 | 87,0 | 134,0 | 113,3 | 118,9 | 95,8 | 114,3 | 92,1 |
| **P Raumordnung und Städtebau; Bauforschung** | **178,3** | **154,3** | **236,8** | **203,0** | **219,3** | **186,6** | **209,9** | **176,3** |
| P 1 Raumordnung, Städtebau, Wohnungswesen | 67,6 | 54,1 | 91,0 | 72,0 | 86,1 | 67,6 | 82,5 | 63,5 |
| P 2 Bauforschung und -technik, Straßenbauforschung | 110,7 | 100,2 | 145,8 | 131,0 | 133,2 | 119,0 | 127,4 | 112,8 |
| **Q Forschung und Entwicklung im Ernährungsbereich** | **78,5** | **72,6** | **77,2** | **71,6** | **80,4** | **74,7** | **83,7** | **77,6** |
| **R Forschung und Entwicklung in der Land- und Forstwirtschaft sowie der Fischerei** | **196,5** | **172,5** | **216,4** | **187,7** | **226,2** | **195,3** | **239,5** | **206,7** |
| **S Bildungs- und Berufsbildungsforschung** | **216,2** | **173,9** | **203,8** | **166,0** | **195,8** | **161,5** | **165,0** | **137,0** |
| **T Innovation und verbesserte Rahmenbedingungen** | **459,3** | **416,3** | **556,3** | **495,5** | **588,7** | **526,7** | **580,0** | **508,4** |
| T 1 Indirekte Förderung des FuE-Personals in der Wirtschaft | 300,0 | 300,0 | 359,3 | 359,3 | 390,0 | 390,0 | 375,0 | 375,0 |
| T 2 Verbesserung des Technologie- und Wissenstransfer | 9,4 | 9,4 | 20,1 | 20,1 | 22,4 | 22,4 | 22,4 | 22,4 |
| T 3 Förderung technologieorientierter Unternehmensgründungen | 3,5 | 3,5 | 3,9 | 3,9 | 6,0 | 6,0 | 5,9 | 5,9 |
| T 4 Übrige indirekte Fördermaßnahmen (ohne indirekt spezifische) | 66,6 | 66,6 | 79,5 | 79,5 | 83,5 | 83,5 | 84,7 | 84,7 |
| T 8 Rationalisierung und wissenschaftlich-technische Ressortdienstleistungen (BMWi) | 50,6 | 7,6 | 64,4 | 3,6 | 65,0 | 3,1 | 74,7 | 3,1 |
| T 9 Übrige Fördermaßnahmen (BMWi) | 29,2 | 29,2 | 29,2 | 29,2 | 21,8 | 21,8 | 17,3 | 17,3 |
| **U Fachinformation** | **100,9** | **67,4** | **95,0** | **54,6** | **104,1** | **58,4** | **102,7** | **50,0** |
| **V Geisteswissenschaften; Wirtschafts- und Sozialwissenschaften** | **283,1** | **185,6** | **327,2** | **219,5** | **356,2** | **232,5** | **355,0** | **230,0** |
| **W Übrige, nicht anderen Bereichen zugeordnete Aktivitäten** | **123,4** | **50,8** | **127,0** | **46,4** | **133,2** | **49,3** | **161,2** | **78,2** |
| **A-W Zivile Förderbereiche zusammen** | **9 263,9** | **7 887,5** | **10 285,6** | **8 835,2** | **11 425,6** | **9 877,2** | **11 349,9** | **9 538,7** |
| **X Wehrforschung und -technik** | **1 828,6** | **1 822,8** | **1 532,8** | **1 527,3** | **1 671,8** | **1 667,2** | **1 842,7** | **1 842,2** |
| **Ausgaben insgesamt** (Y) | **11 092,7** | **9 710,2** | **11 818,2** | **10 362,5** | **13 097,5** | **11 544,5** | **13 192,7** | **11 380,9** |

Key:—1.Subsidized area/priority—2.Actual—3.Total—4.R&D part—L=Materials research: chemical process technology; physical technologies—L1=Materials research—L2=Chemical process technology—L3=Physical technologies—M=Aviation research and development—N=Research and technology for ground transport and traffic (incl. traffic safety)—O=Geosciences and securing of raw materials—O1=Geosciences (in particular deep well drilling)—O2=Securing of raw materials—P=Regional planning and urban development; construction research—P1=Regional planning, urban development, housing—P2=Construction research and technology; road construction research—Q=Research and development in nutrition—R=Research and development in agriculture, forestry and fishing—S=Educational and vocational research—T=Innovation and improved general conditions—T1=Indirect support for R&D personnel in private industry—T2=Improving technology and knowledge transfer—T3=Supporting the establishment of new technology-oriented companies—T4=Other indirect support measures (without indirect specific ones)—T8=Improving efficiency, scientific and technical department support (Federal Ministry for Economic Affairs)—T9=Other support measures (Federal Ministry for Economic Affairs)—U=Technical information—V=Liberal arts; economics and social sciences—W=Other activities not listed above—A-W=Total non-military subsidized areas—X=Military research and technology—Y=Total expenditures
Source Federal Ministry for Research and Technology

**Table VII/8 (Part 4)**

| 1984 Ist (2) | | 1985 Ist (2) | | 1986 Ist (2) | | 1987 Soll (1) | | 1988 Reg.-Entw. (5) | |
|---|---|---|---|---|---|---|---|---|---|
| ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) | ins-gesamt (3) | darunter FuE (4) |
| **433,2** | **329,6** | **466,0** | **352,1** | **508,4** | **396,7** | **558,2** | **451,1** | **658,6** | **505,2** |
| 210,7 | 168,4 | 223,7 | 180,8 | 248,1 | 204,6 | 267,5 | 224,2 | 273,6 | 227,7 |
| 19,9 | 19,9 | 20,9 | 20,9 | 17,8 | 17,8 | 21,4 | 21,4 | 22,9 | 22,9 |
| 202,6 | 141,4 | 221,4 | 150,4 | 242,5 | 174,3 | 269,3 | 205,6 | 362,1 | 254,5 |
| **428,9** | **428,9** | **530,0** | **530,0** | **512,0** | **512,0** | **692,9** | **692,9** | **709,1** | **709,1** |
| **281,0** | **230,2** | **266,6** | **210,1** | **280,6** | **220,3** | **301,5** | **236,0** | **292,2** | **222,5** |
| **209,1** | **148,8** | **205,8** | **145,0** | **190,3** | **131,3** | **165,2** | **123,3** | **194,4** | **150,9** |
| 105,8 | 68,2 | 111,2 | 73,4 | 115,8 | 78,0 | 102,0 | 73,7 | 128,1 | 98,8 |
| 103,3 | 80,6 | 94,6 | 71,7 | 74,5 | 53,2 | 63,3 | 49,6 | 66,3 | 52,1 |
| **185,8** | **161,6** | **180,9** | **159,0** | **192,7** | **171,4** | **170,4** | **147,7** | **174,7** | **151,8** |
| 71,7 | 58,0 | 68,9 | 56,4 | 73,5 | 61,4 | 64,5 | 51,6 | 62,0 | 49,0 |
| 114,1 | 103,6 | 112,0 | 102,6 | 119,2 | 110,0 | 105,8 | 96,1 | 112,7 | 102,8 |
| **83,4** | **77,4** | **86,4** | **80,2** | **93,8** | **87,0** | **87,2** | **81,2** | **89,8** | **83,7** |
| **243,2** | **209,3** | **258,0** | **221,8** | **251,6** | **216,2** | **240,3** | **208,2** | **245,6** | **212,8** |
| **155,1** | **127,1** | **158,6** | **161,3** | **132,6** | **134,5** | **177,1** | **149,2** | **176,4** | **148,3** |
| **550,7** | **468,3** | **678,5** | **586,0** | **732,1** | **642,1** | **839,8** | **754,4** | **628,1** | **497,6** |
| 320,0 | 320,0 | 381,9 | 381,9 | 409,0 | 409,0 | 475,0 | 475,0 | 230,0 | 230,0 |
| 30,2 | 30,2 | 51,7 | 51,7 | 70,7 | 70,7 | 77,6 | 77,6 | 82,0 | 82,0 |
| 16,1 | 16,1 | 41,9 | 41,9 | 48,2 | 48,2 | 80,0 | 80,0 | 63,0 | 63,0 |
| 84,9 | 84,9 | 94,8 | 94,8 | 96,8 | 96,8 | 101,0 | 101,0 | 101,0 | 101,0 |
| 85,5 | 3,0 | 94,5 | 2,0 | 92,9 | 2,9 | 88,6 | 3,2 | 133,7 | 3,2 |
| 14,1 | 14,1 | 13,7 | 13,7 | 14,5 | 14,5 | 17,7 | 17,7 | 18,4 | 18,4 |
| **105,3** | **51,1** | **127,3** | **68,8** | **154,6** | **94,5** | **148,3** | **89,8** | **145,9** | **92,6** |
| **355,2** | **227,3** | **386,9** | **245,8** | **410,3** | **265,6** | **434,5** | **288,6** | **450,3** | **292,9** |
| **162,4** | **73,7** | **182,8** | **82,8** | **195,5** | **94,6** | **237,5** | **132,6** | **274,0** | **165,4** |
| **11 527,7** | **9 715,8** | **12 013,1** | **10 225,0** | **12 234,4** | **10 319,4** | **12 881,5** | **11 006,4** | **12 982,5** | **10 958,4** |
| **1 064,8** | **1 964,1** | **2 477,2** | **2 476,4** | **2 507,7** | **2 506,9** | **2 808,2** | **2 807,4** | **2 772,8** | **2 772,0** |
| **13 492,5** | **11 679,9** | **14 490,2** | **12 701,2** | **14 742,2** | **12 826,3** | **15 689,7** | **13 813,7** | **15 755,4** | **13 730,2** |

(6) Rundungsdifferenzen

Key:—1.Projected—2.Actual—3.Total—4.R&D part—5.1988 government proposal—6.Differences due to rounding

Table II/10

Share of Basic Research in Federal R&D Expenditures

| Year | Federal R&D Expenditures in Million DM | Share of Basic Research in Million DM | as a percentage |
|---|---|---|---|
| 1981 | 10,362.5 | 2,552.5 | 24.6 |
| 1982 | 11,544.5 | 2,687.2 | 23.3 |
| 1983 | 11,380.9 | 2,852.7 | 25.1 |
| 1984 | 11,679.9 | 3,126.1 | 26.8 |
| 1985 | 12,701.2 | 3,334.1 | 26.3 |
| 1986 | 12,826.3 | 3,525.1 | 27.5 |

Source: Federal Ministry for Research and Technology

## Funding by Laender, BMFT

*36980313 Bonn BUNDESBERICHT FORSCHUNG in German March 1988 82-97, 371-373*

[Excerpts]

### 6. Expenditures of the Individual States for Research and Development

In 1985, the states spent approximately DM7.1 billion for research and development, which is 11 percent more than the corresponding expenditures for 1981. However, one has to take into consideration that the data for 1981 and 1985 are not completely comparable, since starting in 1983 the survey of R&D data only covers the R&D portions of the state research institutions—as is the case with the federal research institutions. Without this change in methodology, the increase of R&D expenditures for 1985 would be over 13 percent. This would correspond to an average annual increase of more than 3 percent. Current estimates for 1987 indicate another 7 percent increase over 1985 to DM7.6 billion.

A complete listing of state expenditures by individual states is only available for the science area (see table II/12 and table VII/15). Determination of R&D expenditures largely depends on how the university sector is treated. Here, the separation of research and teaching on the one hand as well as the problem of capturing funds from third parties play a part. Currently, R&D expenditures by universities cannot be fully listed according to financing sectors and states (see also table VII/40), so that only state expenditure for science can be included here. For the calculation of R&D expenditures refer to the comments on methodology in part VII.

The predominant part of state R&D expenditures goes to universities; in 1985 they accounted for slightly less than 71 percent. While this is a decrease in the share of universities compared to 1983, financing of research and development outside universities gained in importance. This refers primarily to funds for research institutions included in the state budgets which are fully financed by the states to carry out their own projects and whose R&D portion is included here. It also includes the research institutions which are jointly subsidized by the federal and state governments pursuant to article 91b; included here is that part of R&D expenditure financing which is contributed by the states. Also included are R&D expenditures by the states for project support in non-university research institutions.

In 1985, state expenditures for financing research and development in private industry amounted to over 5 percent, which is slightly higher than in 1983.

### 7. Joint Federal and State Research Support

Joint federal and state research support covers institutions and projects of national signifiance and of scientific interest to the whole country; it is based on article 91b of the Basic Law and is regulated in the general agreement on research support of 28 Nov 1975. At present, the following institutions and projects receive support on this basis:

- German Research Society (DFG) including special research areas (SFB),
- Max-Planck-Society (MPG),
- Fraunhofer-Society (FhG),
- 13 large-scale research facilities,
- 47 Blue List research institutions,
- Academic program with 94 projects (as of 1987).

An agreement was made on how to pro-rate financial research support for the individual institutions between federal and state governments (for details see Part VI).

In 1986, institutional support for these facilities totalled DM4.7 billion compared to DM4.5 billion in 1985 (+5.4 percent). DM5.7 billion (projected) is earmarked for 1987, which is an 8 percent increase compared to actual 1986 figures. In the past few years, the increase in the

**Table VII/15: State and Local Government Expenditures for Science According to States (Net Expenditures)**

| (1) Land | (2) Jahr 1) | (3) Hochschulen einschließlich Hochschulkliniken 2) | (4) Wissenschaft und Forschung außerhalb der Hochschulen | (5) Wissenschaftsausgaben zusammen 2) (Nettoausgaben) | | (6) finanziert durch (7) Land 3) | (8) Gemeinden |
|---|---|---|---|---|---|---|---|
| | | (9) Mio DM | | | % | (9) Mio DM | |
| Baden-Württemberg | 1979 | 2 450,8 | 283,2 | **2 734,0** | *16,0* | 2 726,5 | 7,5 |
| | 1980 | 2 723,5 | 315,9 | **3 039,4** | *16,1* | 3 031,9 | 7,5 |
| | 1981 | 2 790,0 | 349,0 | **3 139,0** | *15,6* | 3 130,9 | 8,1 |
| | 1982 | 2 978,3 | 359,9 | **3 338,2** | *16,0* | 3 331,0 | 7,2 |
| | 1983 | 3 132,4 | 388,3 | **3 520,7** | *16,3* | 3 512,5 | 8,2 |
| | 1984 | 3 199,6 | 422,4 | **3 622,1** | *16,2* | 3 619,2 | 2,9 |
| | 1985 | 3 332,6 | 474,4 | **3 806,9** | *15,8* | 3 801,7 | 5,3 |
| | 1986 | 3 475,2 | 598,1 | **4 073,3** | *16,7* | 4 068,0 | 5,3 |
| | 1987 | 3 770,9 | 602,0 | **4 372,9** | *16,9* | 4 367,6 | 5,3 |
| Bayern (10) | 1979 | 2 246,3 | 331,9 | **2 578,2** | *15,1* | 2 566,3 | 11,9 |
| | 1980 | 2 491,2 | 361,2 | **2 852,4** | *15,1* | 2 838,6 | 13,7 |
| | 1981 | 2 640,0 | 391,5 | **3 031,5** | *15,2* | 3 018,2 | 13,3 |
| | 1982 | 2 773,1 | 423,8 | **3 196,9** | *15,3* | 3 181,6 | 15,3 |
| | 1983 | 2 910,5 | 437,0 | **3 347,5** | *15,5* | 3 332,9 | 14,6 |
| | 1984 | 3 062,9 | 448,2 | **3 511,1** | *15,7* | 3 492,9 | 18,3 |
| | 1985 | 3 273,7 | 474,7 | **3 748,5** | *15,5* | 3 726,0 | 22,4 |
| | 1986 | 3 403,1 | 538,3 | **3 941,4** | *16,2* | 3 919,0 | 22,4 |
| | 1987 | 3 682,5 | 601,1 | **4 283,6** | *16,5* | 4 261,2 | 22,4 |
| Berlin (West) | 1979 | 1 367,7 | 98,8 | **1 466,5** | *8,6* | 1 466,5 | – |
| | 1980 | 1 505,6 | 111,4 | **1 617,0** | *8,5* | 1 617,0 | – |
| | 1981 | 1 595,7 | 119,0 | **1 714,7** | *8,6* | 1 714,7 | – |
| | 1982 | 1 610,9 | 129,6 | **1 740,5** | *8,3* | 1 740,5 | – |
| | 1983 | 1 668,5 | 149,2 | **1 817,7** | *8,4* | 1 817,7 | – |
| | 1984 | 1 660,0 | 172,7 | **1 832,7** | *8,2* | 1 832,7 | – |
| | 1985 | 1 767,2 | 184,9 | **1 952,1** | *8,1* | 1 952,1 | – |
| | 1986 | 1 807,4 | 183,6 | **1 991,0** | *8,2* | 1 991,0 | – |
| | 1987 | 1 895,9 | 181,7 | **2 077,6** | *8,0* | 2 077,6 | – |
| Bremen | 1979 | 118,0 | 28,9 | **146,9** | *0,9* | 146,9 | – |
| | 1980 | 136,9 | 27,4 | **164,3** | *0,9* | 164,3 | – |
| | 1981 | 161,0 | 30,0 | **191,0** | *1,0* | 191,0 | – |
| | 1982 | 166,2 | 30,9 | **197,1** | *0,9* | 197,1 | – |
| | 1983 | 175,1 | 34,8 | **209,9** | *1,0* | 209,9 | – |
| | 1984 | 170,7 | 32,4 | **203,1** | *0,9* | 203,1 | – |
| | 1985 | 174,5 | 39,3 | **213,7** | *0,9* | 213,7 | – |
| | 1986 | 170,3 | 42,1 | **212,4** | *0,9* | 212,4 | – |
| | 1987 | 172,0 | 36,5 | **208,5** | *0,8* | 208,5 | – |

Fußnoten und Quellenangabe am Schluß der Tabelle (11) (12) Rundungsdifferenzen

Key:—1.State—2.Year 2)—3.Universities including university hospitals 2)—4.Science and research outside universities—5.Total expenditures for science 2)(net expenditures)—6.Financed by—7.State 3)—8.Local governments—9.Million DM—10.Bavaria—11.Footnotes and source reference at the end of the table—12.Differences due to rounding

Table VII/15 (Continued)

| (1) Land | (2) Jahr[1] | (3) Hochschulen einschließlich Hochschulkliniken[2] | (4) Wissenschaft und Forschung außerhalb der Hochschulen | (5) Wissenschaftsausgaben zusammen[2] (Nettoausgaben) | | (6) finanziert durch (7) Land[3] | (8) Gemeinden |
|---|---|---|---|---|---|---|---|
| | | (9) Mio DM | | | % | (9) Mio DM | |
| Hamburg | 1979 | 601,2 | 74,8 | **676,0** | *4,0* | 676,0 | – |
| | 1980 | 720,3 | 75,1 | **795,4** | *4,2* | 795,4 | – |
| | 1981 | 760,9 | 73,0 | **833,9** | *4,2* | 833,9 | – |
| | 1982 | 820,7 | 92,8 | **913,5** | *4,4* | 913,5 | – |
| | 1983 | 841,8 | 82,5 | **924,3** | *4,3* | 924,3 | – |
| | 1984 | 865,6 | 89,1 | **954,7** | *4,3* | 954,7 | – |
| | 1985 | 929,3 | 102,7 | **1 032,0** | *4,3* | 1 032,0 | – |
| | 1986 | 981,0 | 111,8 | **1 093,7** | *4,5* | 1 093,7 | – |
| | 1987 | 1 061,5 | 119,9 | **1 181,4** | *4,6* | 1 181,4 | – |
| Hessen | 1979 | 1 467,8 | 168,0 | **1 635,8** | *9,6* | 1 597,3 | 38,4 |
| | 1980 | 1 608,6 | 169,8 | **1 778,4** | *9,4* | 1 737,3 | 41,2 |
| | 1981 | 1 726,0 | 188,6 | **1 914,6** | *9,5* | 1 868,4 | 46,2 |
| | 1982 | 1 806,8 | 204,9 | **2 011,7** | *9,6* | 1 967,1 | 44,0 |
| | 1983 | 1 870,3 | 223,1 | **2 093,4** | *9,7* | 2 044,7 | 48,7 |
| | 1984 | 1 944,7 | 218,6 | **2 163,4** | *9,7* | 2 122,2 | 41,1 |
| | 1985 | 2 082,1 | 232,7 | **2 314,9** | *9,6* | 2 258,3 | 56,6 |
| | 1986 | 2 073,4 | 262,2 | **2 335,6** | *9,6* | 2 279,0 | 56,6 |
| | 1987 | 2 090,5 | 277,1 | **2 367,6** | *9,1* | 2 311,0 | 56,6 |
| Niedersachsen (10) | 1979 | 1 499,3 | 201,0 | **1 700,3** | *9,9* | 1 688,7 | 11,7 |
| | 1980 | 1 691,0 | 227,0 | **1 918,0** | *10,1* | 1 907,3 | 10,8 |
| | 1981 | 1 810,3 | 248,7 | **2 059,0** | *10,3* | 2 045,4 | 13,6 |
| | 1982 | 1 905,0 | 246,1 | **2 151,1** | *10,3* | 2 140,2 | 10,9 |
| | 1983 | 1 958,7 | 242,3 | **2 201,0** | *10,2* | 2 188,7 | 12,3 |
| | 1984 | 2 013,0 | 251,3 | **2 264,3** | *10,2* | 2 253,5 | 10,8 |
| | 1985 | 2 143,4 | 274,0 | **2 417,4** | *10,0* | 2 404,1 | 13,2 |
| | 1986 | 2 196,4 | 308,8 | **2 505,2** | *10,3* | 2 492,0 | 13,2 |
| | 1987 | 2 344,1 | 357,5 | **2 701,6** | *10,4* | 2 688,4 | 13,2 |
| Nordrhein-Westfalen | 1979 | 4 009,0 | 534,4 | **4 543,4** | *26,6* | 4 430,1 | 113,3 |
| | 1980 | 4 398,2 | 585,0 | **4 984,1** | *26,3* | 4 847,1 | 136,9 |
| | 1981 | 4 624,0 | 595,8 | **5 219,8** | *26,2* | 5 083,2 | 136,6 |
| | 1982 | 4 726,3 | 589,1 | **5 315,4** | *25,4* | 5 192,2 | 123,2 |
| | 1983 | 4 750,1 | 594,9 | **5 345,0** | *24,8* | 5 214,6 | 130,4 |
| | 1984 | 4 934,4 | 619,6 | **5 554,0** | *24,9* | 5 423,4 | 130,5 |
| | 1985 | 5 527,7 | 768,8 | **6 296,6** | *26,1* | 6 147,8 | 148,8 |
| | 1986 | 4 960,8 | 745,4 | **5 706,2** | *23,4* | 5 557,4 | 148,8 |
| | 1987 | 5 258,1 | 750,6 | **6 008,7** | *23,2* | 5 859,9 | 148,8 |

Fußnoten und Quellenangabe am Schluß der Tabelle (11) (12) Rundungsdifferenzen

Key:—1.State—2.Year [2])—3.Universities including university hospitals [2])—4.Science and research outside universities—5.Total expenditures for science [2])(net expenditures)—6.Financed by—7.State [3])—8.Local governments—9.Million DM—10.Lower Saxony—11.Footnotes and source reference at the end of the table—12.Differences due to rounding

Table VII/15 (Continued)

| (1) Land | (2) Jahr[1]) | (3) Hochschulen einschließlich Hochschulkliniken[2]) | (4) Wissenschaft und Forschung außerhalb der Hochschulen | (5) Wissenschaftsausgaben zusammen[2]) (Nettoausgaben) | | (6) finanziert durch (7) Land[3]) | (8) Gemeinden |
|---|---|---|---|---|---|---|---|
| | | (9) Mio DM | | | % | (9) Mio DM | |
| Rheinland-Pfalz | 1979 | 593,7 | 81,1 | **674,8** | 3,9 | 663,8 | 11,0 |
| | 1980 | 669,6 | 82,0 | **751,6** | *4,0* | 745,5 | 6,1 |
| | 1981 | 715,7 | 85,4 | **801,1** | *4,0* | 795,2 | 5,9 |
| | 1982 | 765,5 | 88,9 | **854,4** | *4,1* | 848,2 | 6,2 |
| | 1983 | 786,0 | 94,9 | **880,9** | *4,1* | 873,9 | 7,0 |
| | 1984 | 815,5 | 102,3 | **917,7** | *4,1* | 910,2 | 7,5 |
| | 1985 | 900,7 | 114,2 | **1 014,9** | *4,2* | 1 007,0 | 7,9 |
| | 1986 | 923,1 | 147,5 | **1 070,6** | *4,4* | 1 062,7 | 7,9 |
| | 1987 | 956,8 | 163,7 | **1 120,5** | *4,3* | 1 112,6 | 7,9 |
| Saarland | 1979 | 318,5 | 14,1 | **332,6** | *1,9* | 332,3 | 0,1 |
| | 1980 | 346,7 | 15,1 | **361,8** | *1,9* | 361,5 | 0,3 |
| | 1981 | 329,7 | 15,2 | **344,9** | *1,7* | 344,5 | 0,4 |
| | 1982 | 376,8 | 15,1 | **391,9** | *1,9* | 391,7 | 0,2 |
| | 1983 | 411,5 | 15,4 | **426,9** | *2,0* | 426,6 | 0,3 |
| | 1984 | 429,8 | 17,2 | **446,9** | *2,0* | 446,8 | 0,1 |
| | 1985 | 443,6 | 18,1 | **461,7** | *1,9* | 461,4 | 0,3 |
| | 1986 | 470,0 | 25,8 | **495,8** | *2,0* | 495,5 | 0,3 |
| | 1987 | 510,7 | 28,6 | **539,3** | *2,1* | 539,0 | 0,3 |
| Schleswig-Holstein | 1979 | 538,2 | 62,0 | **600,2** | *3,5* | 594,1 | 6,1 |
| | 1980 | 590,2 | 67,3 | **657,5** | *3,5* | 651,7 | 5,8 |
| | 1981 | 655,4 | 70,6 | **726,0** | *3,6* | 719,6 | 6,4 |
| | 1982 | 705,7 | 76,7 | **782,4** | *3,7* | 779,8 | 2,6 |
| | 1983 | 707,8 | 77,5 | **785,3** | *3,6* | 777,2 | 8,1 |
| | 1984 | 753,5 | 84,4 | **837,9** | *3,8* | 827,4 | 10,5 |
| | 1985 | 784,5 | 96,5 | **881,0** | *3,6* | 869,3 | 11,7 |
| | 1986 | 872,8 | 100,9 | **973,7** | *4,0* | 962,0 | 11,7 |
| | 1987 | 953,9 | 118,3 | **1 072,2** | *4,1* | 1 060,5 | 11,7 |
| **Insgesamt** (10) | 1979 | **15 210,5** | **1 878,0** | **17 088,5** | *100* | **16 888,3** | **200,1** |
| | 1980 | **16 881,8** | **2 038,1** | **18 919,9** | *100* | **18 697,6** | **222,3** |
| | 1981 | **17 808,7** | **2 166,8** | **19 975,5** | *100* | **19 745,0** | **230,5** |
| | 1982 | **18 635,2** | **2 257,7** | **20 892,9** | *100* | **20 682,8** | **210,1** |
| | 1983 | **19 212,5** | **2 339,6** | **21 552,1** | *100* | **21 322,7** | **229,4** |
| | 1984 | **19 849,6** | **2 458,3** | **22 308,0** | *100* | **22 086,1** | **221,9** |
| | 1985 | **21 359,3** | **2 780,3** | **24 139,6** | *100* | **23 873,4** | **266,2** |
| | 1986 | **21 334,3** | **3 064,4** | **24 398,7** | *100* | **24 132,5** | **266,2** |
| | 1987 | **22 696,8** | **3 236,9** | **25 933,7** | *100* | **25 667,5** | **266,2** |

Key:—1.State—2.Year [2])—3.Universities including university hospitals [2])—4.Science and research outside universities—5.Total expenditures for science [2])(net expenditures)—6.Financed by—7.State [3])—8.Local governments—9.Million DM—10.Total.

[1]) *States: actual figures until 1985, projected figures from 1986; local governments: estimates from 1986.*

[2]) *Including hospitals following commercial accounting principles, unless they are no longer carried in the state budget in gross figures starting in 1978.*

[3]) *Including state revenues (including medical care revenues) for medical care at university hospitals.*

Source: Federal Office of Statistics

Differences due to rounding

**Table II/13: Joint Federal and State Research Support, 1985 to 1987 (in Million DM)**

| (1) Einrichtungen | 1985 Ist (2) | | | 1986 Ist (3) | | | 1987 Soll (4) | | |
|---|---|---|---|---|---|---|---|---|---|
| | insgesamt (5) | Bund (6) | Länder (7) | insgesamt (5) | Bund (6) | Länder (7) | insgesamt (5) | Bund (6) | Länder (7) |
| Max-Planck-Gesellschaft .(8)... | 787,3 | 393,7 | 393,7 | 816,4 | 407,0 | 409,4 | 863,4 | 421,7 | 441,7 |
| Deutsche Forschungsgemeinschaft | 946,9 | 549,5 | 397,4 | 960,0 | 560,1 | 399,9 | 1021,6 | 596,1 | 425,5 |
| davon: (9) | | | | | | | | | |
| – allgemeine Förderung .(10). | 629,2 | 314,6 | 314,6 | 625,5 | 312,8 | 312,8 | 667,0 | 333,5 | 333,5 |
| – Sonderforschungsbereiche .(11) | 302,9 | 227,2 | 75,7 | 312,1 | 234,1 | 78,0 | 321,5 | 241,1 | 80,4 |
| – Heisenberg-Programm ..(12) | 13,8 | 6,9 | 6,9 | 14,4 | 7,2 | 7,2 | 14,0 | 7,0 | 7,0 |
| – Friedens- und Konfliktforschung ..(13).... | 1,0 | 0,8 | 0,2 | 2,0 | 1,6 | 0,4 | 3,1 | 2,5 | 0,6 |
| – Spitzenforschung ....(14)... | – | – | – | 6,0 | 4,5 | 1,5 | 16,0 | 12,0 | 4,0 |

Key:—1.Institutions—2.Actual 1985—3.Actual 1986—4.Projected 1987—5.Total—6.Federal—7.State—8.Max Planck Society—9.German Research Association, of those—10.General support—11.Special support areas—12.Heisenberg program—13.Peace and conflict research—13.Top research

percentage provided by the federal government was slightly higher than that of the states. In the years 1985 to 1987, the federal government contributed an average of approximately 72 percent to joint research support by federal and state government (see table II/13).

If we look at the individual institutions which received support the DFG (see Part VI, section 2.1) and MPG (see Part VI, section 3.1) hold a special position, since they receive financing from all states in addition to federal support. Institutional support for both institutions is basically divided 50 : 50, the special research areas which account for approx. 32 percent of DFG funds are an exception; they are financed 75 : 25 by the federal and state governments. In 1987, DFG and MPG will account for 36.7 percent of joint federal and state research support, which constitutes a slight decrease over the past two years. In 1985, it amounted to 38.5 percent.

The Fraunhofer-Society is sponsored jointly by the federal government and the seven states in which it is located (see Part VI, section 3.2). Based on projected data for 1987, its part of joint research support increased slightly (3.7 percent versus 3.4 percent in 1985). In addition to federal support, the 13 large-scale research facilities basically receive institutional support only from the respective state or states in which they are located; the financing ratio is 90 :10 (see Part VI, section 4). In the past few years, there was a slight increase in the share of large-scale research facilities in the total institutional research support by federal and state governments. In 1987, it amounts to slightly less than 50 percent compared to 48.6 percent in 1985.

In addition to the large-scale research facilities, smaller institutions are also included in the joint federal and state research support. The respective Blue List research facilities comprise 35 institutions which are supported by the federal government and by the state in which they are located, and 12 service institutions which are supported by the federal government and by all states (see Part VI, section 5). In addition, federal and state governments jointly support a program coordinated by the Academies of Sciences. At present, it consists of 94 projects of the five Academies of Sciences (Goettingen, Munich, Heidelberg, Mainz, and Duesseldorf).

## 8. Support for Research and Development in Private Industry

### Research and Development in Private Industry

New scientific discoveries and their application in new products and processes are essential for the continued viability of the German economy in international competition, for prosperity, employment, and for meeting the challenges of the future. This is all the more true since prosperity in the Federal Republic of Germany is largely based on a close integration of German industry in the international division of labor. One out of three people employed in industry is working for export, and one third of the German gross national product is earned through exports.

According to the Ifo-Innnovation tests for the Federal Republic of Germany [1] many companies are currently faced with the problem that they have to recapture higher innovation expenditures in shorter innovation cycles. Therefore, companies must not only develop innovation into marketable products, but must do so in a timely manner, because in tough competition latecomers run the risk of not being able to recapture their innovation expenditures in the market.

**Table II/13 (Continued)**

| (1) Einrichtungen | 1985 Ist (2) | | | 1986 Ist (3) | | | 1987 Soll (4) | | |
|---|---|---|---|---|---|---|---|---|---|
| | insgesamt (5) | Bund (6) | Länder (7) | insgesamt (5) | Bund (6) | Länder (7) | insgesamt (5) | Bund (6) | Länder (7) |
| Arbeitsstelle Friedensforschung Bonn ... (8) ... | 0,5 | 0,4 | 0,1 | 0,5 | 0,4 | 0,1 | 0,5 | 0,4 | 0,1 |
| Fraunhofer-Gesellschaft[1]) .. (9) .. | 152,7 | 121,8 | 30,9 | 155,1 | 120,3 | 34,8 | 189,3 | 141,0 | 48,3 |
| Akademienprogramm .... (10) . | 27,3 | 13,6 | 13,6 | 29,3 | 14,7 | 14,7 | 30,4 | 15,2 | 15,2 |
| Großforschungseinrichtungen (11) | 2187,7 | 1962,1 | 225,6 | 2355,4 | 2103,1 | 252,3 | 2555,1 | 2288,8 | 266,3 |
| davon: (12) | | | | | | | | | |
| – Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven (AWI)[2]) . (13) .. | 62,6 | 52,8 | 9,8 | 70,7 | 57,5 | 13,3 | 72,5 | 62,8 | 9,7 |
| – Deutsches Elektronen-Synchrotron, Hamburg (DESY) .. (14) . | 247,6 | 216,4 | 31,2 | 324,9 | 282,9 | 42,0 | 371,9 | 329,7 | 42,2 |
| – Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V., Köln (DFVLR)[3]) . (15) | 301,2 | 270,7 | 30,5 | 309,0 | 278,1 | 30,9 | 323,5 | 291,1 | 32,3 |
| – Deutsches Krebsforschungszentrum, Heidelberg (DKFZ) (16) | 96,4 | 86,7 | 9,6 | 102,7 | 92,4 | 10,3 | 114,5 | 103,1 | 11,5 |
| – Gesellschaft für Biotechnologische Forschung mbH, Braunschweig-Stöckheim (GBF) .. (17) | 30,2 | 27,2 | 3,0 | 40,7 | 36,7 | 4,1 | 61,1 | 55,0 | 6,1 |
| – GKSS – Forschungszentrum Geesthacht GmbH, Geesthacht (GKSS) ..... (18) .......... | 84,9 | 76,4 | 8,5 | 88,5 | 79,7 | 8,9 | 90,0 | 81,0 | 9,0 |
| – Gesellschaft für Mathematik und Datenverarbeitung mbH, (19) St. Augustin bei Bonn (GMD) . | 62,5 | 56,2 | 6,3 | 78,5 | 70,7 | 7,8 | 80,8 | 72,7 | 8,1 |
| – Gesellschaft für Strahlen- und Umweltforschung mbH, Neu- (20) herberg bei München (GSF) .. | 122,1 | 111,7 | 10,4 | 122,4 | 111,8 | 10,6 | 129,2 | 117,9 | 11,3 |
| – Gesellschaft für Schwerionenforschung mbH, Darmstadt (GSI) . (21) ............... | 85,6 | 78,0 | 7,6 | 104,1 | 95,8 | 8,4 | 133,9 | 125,6 | 8,3 |
| – Hahn-Meitner-Institut Berlin GmbH, Berlin (HMI) . (22) | 98,9 | 89,0 | 9,9 | 103,6 | 93,3 | 10,4 | 111,0 | 99,9 | 11,1 |
| – Max-Planck-Institut für Plasmaphysik GmbH, Garching bei München (IPP) .. (23) ...... | 87,9 | 79,2 | 8,8 | 95,7 | 86,1 | 9,6 | 94,4 | 85,0 | 9,4 |
| – Kernforschungsanlage Jülich GmbH, Jülich (KFA) (24) | 410,4 | 368,7 | 41,7 | 414,5 | 367,2 | 47,3 | 458,0 | 400,8 | 57,2 |
| – Kernforschungszentrum Karlsruhe GmbH, Karlsruhe (KfK) (25) | 497,3 | 449,0 | 48,3 | 499,9 | 451,2 | 48,7 | 514,3 | 464,2 | 50,1 |
| Einrichtungen der „Blauen Liste"[4]) | 401,4 | 213,1 | 188,3 | 432,1[5]) | 229,8[5]) | 202,3[5]) | 469,6 | 252,9 | 216,7 |
| Insgesamt . (27) ....... (26) ....... | 4503,7 | 3254,1 | 1249,6 | 4748,8 | 3435,4 | 1313,4 | 5129,9 | 3716,1 | 1413,8 |

Key:—1.Institutions—2.Actual 1985—3.Actual 1986—4.Projected 1987—5.Total—6.Federal—7.state—8.Peace research agency Bonn—9.Fraunhofer-Society [1]program—11.Large-scale research facilities—12.Of those—13.Alfred-Wegener Institute for Polar and Oceanic Research, Bremerhaven (AWI) [2])—14.German Electron Synchotron, Hamburg (DESY)—15.German Research and Test Institute for Aviation and Space Flights, reg. association, Cologne, (DFVL)—16.German Cancer Research Center, Heidelberg (DKFZ)—17.Association for Biotechnological Research mbH, Braunschweig-Stoeckheim (GBF)—18.GKSS - Research Center Geesthacht GmbH, Geesthacht (GKSS)—19.Society for Mathematics and Data Processing mbH, St. Augustin near Bonn (GMD—20.Society for Radiation and Environmental Research mbH, Neuherberg near Munich (GSF)—21.Society for Heavy Ion Research mbH, Darmstadt (GSI)—22.Hahn-Meitner-Institute Berlin GmbH, Berlin (HMI)—23.Max Planck Institute for Plasma Physics GmbH, Garching near Munich (IPP)—24. Nuclear Research Facility Juelich GmbH, Juelich (KFA)—25.Nuclear Research Center Karlsruhe GmbH, Karlsruhe (KFK)—26. "Blue List" facilities [4])—27.Total

[1]) *Excluding institutional support by the Federal Ministry of Defense, since it is not subject to joint federal/state financing.*

[2])*Including the Institute for Oceanography, Bremerhaven.*

[3])*Excluding a lump-sum payment from the Federal Ministry of Defense amounting to DM20 million or DM24 million in 1987 since it is not subject to joint federal/state financing.*

[4])*Excluding the Institute for Oceanographic Research, Bremerhaven*

[5])*Actual 1986*

Source: Economic Plans, printed in the federal budget draft for 1987 and 1988; Federal Ministry for Research and Technology; Federal/State Commission for Educational Planning and Research Support, Bonn

Differences due to rounding

Intensive research and development by private industry is an essential prerequisite for successful innovations. Total R&D expenditures by private industry (implemented R&D, internally and externally), which amounted to DM27.8 billion in 1981, increased to DM44.2 billion in 1987, i.e. an increase of approximately 59 percent[2].

The three large chemical industry areas with approximately 20 percent, steel, machine and automobile construction with approximately 34 percent and electronics/electrical engineering, precision machining and optics with approximately 31 percent continue to account for the major portion of total R&D expenditures by private industry. In 1987, these three sectors together account for about 85 percent of total R&D expenditures by companies. In 1985, these industries earned about 49 percent of the gross added value by manufacturing industries and created 21 percent of total value added (see diagram II/12).

In 1985, in-house research and development by private industry amounted to 3.2 percent (1981: 2.8 percent) of sales. According to surveys by the Founder Association the following areas are particularly research-oriented: electronics/electrical engineering, 7.8 percent (1981: 7.2 percent), precision engineering, optics, 5.3 percent (1981: 5.3 percent), chemical industry 4.8 percent (1981: 4.6 percent), automobile and automobile parts manufacturing 3.7 percent (1981: 3.5 percent), and mechanical engineering 3.3 percent (1981: 3.1 percent). These industries also employ the major part of R&D personnel (in full-time equivalents) in private industry: in 1985, the chemical industry with approx. 56,000 researchers, steel, machine and automotive industries with approx. 97,000 researchers, and electronics/electrical engineering, precision engineering and optics with approx. 86,000 researchers employed 88 percent of the total R&D personnel in private industry research facilities. In 1985, a total of 271,500 researchers worked in private industry research facilities; in addition, 3,600 researchers worked in joint research institutions.

The sectors which are important for R&D personnel employment and the creation of value for the economy as a whole generated their high R&D expenditures largely from internal funds. Their own contributions ranged from about 98 percent for the chemical industry to 89 percent for electronics/electrical engineering. These industries also played a major part in foreign trade. In 1986, automobile construction (21.6 percent), electronics/electrical engineering including precision engineering and optics (13.0 percent), chemical industry (16.4 percent), and mechanical engineering (16.6 percent) accounted for over two thirds of foreign sales in manufacturing and mining (see Statistical Yearbook 1987, Sales of Mining and Manufacturing Companies, page 180).

**Project Support by the Federal Ministry for Research and Technology (BMFT) by Topics**

BMFT support of R&D covers the following topics:

- Basic research extending beyond individual programs (1)
- Long-term government programms (2)
- Quality of life (preventive research) (3)
- Market-oriented technology support (4)
- General conditions, infrastructure (5).

Direct project support by BMFT for private industry is concentrated on energy, oceanography, information technologies, biotechnology, materials research, traffic and aviation research. In 1987, total direct project support for market-oriented technologies which are intended to strengthen the economic performance of private companies, amounted to approx. DM1.3 billion. This corresponds to 43.6 percent of the total direct project support and 18.1 percent of the BMFT budget.

BMFT support for long-term government programs such as oceanography, space or nuclear fusion research as well as support for preventive research such as environmental, safety or health research also includes private companies. However, in these cases, the government's interest in the research results takes precedence (for direct BMFT project support and the amount going to private industry see table II/16).

Market-oriented project support and total project support for private industry has declined since 1982. While funding for energy research showed a large decrease, funding for modern key technologies, in particular information and communications technology, biotechnology and materials research increased (see table II/17).

The new orientation of research support for private industry, i.e. away from individual support for a maximum number of projects in a large number of different fields to more long-term, larger projects which are in the pre-competitive stage can be seen from the number of supported projects. In 1986, it clearly declined to approximately 2,000 projects.

**Joint Research**

In addition to reducing the number of direct support projects the support approach was also changed: the new concept of joint research makes it possible to promote coperation of science and industry. The support tool "Joint Research" also results in a further increase in R&D support efficiency.

By having—ideally—several companies and research institutions participate in a project, joint industrial research wants to better utilize scarce research capacities by concentrating resources, accelerate technology transfer between private industry and science, generate a synergistic effect and make support less selective and more broad-based. Joint industrial research can also provide a better chance for small and medium-sized companies to participate in research projects. Examples are joint projects in information technology, materials research, in the area of worklife humanization and manufacturing technology, in which a considerable number of small and medium-sized companies participate.

**Table II/17: Direct BMFT Project Support, 1984 to 1987 - Implementing Institutions of Private Industry according to Profiles, Supported Areas and Support Priorities**

| Profil Förderbereich/Förderschwerpunkt (a) | Fördermittel in TDM (b) | | | |
|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987[1] |
| **1 Programmübergreifende Grundlagenforschung** | | | | |
| B Sonderbereiche der Grundlagenforschung (insbesondere Großgeräte) | 56 | – | – | – |
| O1 Geowissenschaften (insbesondere Tiefbohrungen) | – | 113 | 37 | – |
| Summe 1 | 56 | 113 | 37 | – |
| **2 Staatliche Langzeitprogramme** | | | | |
| C1 Meeresforschung | 32 261 | 38 623 | 38 066 | 2 932 |
| D Weltraumforschung und Weltraumtechnik | 201 594 | 205 944 | 177 617 | 212 835 |
| Summe 2 | 233 855 | 244 566 | 215 683 | 215 768 |
| **3 Lebensbedingungen (Vorsorgeforschung)** | | | | |
| F1 Ökologische Forschung | 2 255 | 2 545 | 2 280 | 3 861 |
| F2 Umweltschonende und Umweltschutztechnologien | 53 746 | 63 116 | 63 551 | 60 825 |
| F5 Wasserforschung | 7 256 | 6 346 | 2 426 | 2 157 |
| F8 Sicherheitsforschung und Sicherheitstechnik | 2 288 | 2 475 | 4 680 | 3 576 |
| G Forschung und Entwicklung im Dienste der Gesundheit | 28 696 | 20 441 | 17 532 | 11 678 |
| H Forschung und Entwicklung zur Humanisierung des Arbeitslebens | 48 546 | 56 654 | 55 346 | 50 611 |
| P2 Bauforschung und -technik | 21 176 | 15 477 | 11 337 | 10 419 |
| W1 Querschnittsaktivitäten (einschl. Technikfolgenabschätzung) | 1 309 | 860 | 871 | 1174 |
| Summe 3 | 165 271 | 167 915 | 158 023 | 144 300 |
| **4 Marktorientierte Technologieförderung** | | | | |
| C2 Meerestechnik | 41046 | 36908 | 27453 | 23700 |
| E1 Kohle und andere fossile Energieträger | 262069 | 208207 | 201662 | 191057 |
| E2 Erneuerbare Energiequellen und rationelle Energieverwendung | 149 699 | 142 522 | 121 073 | 120 997 |
| E3 Nukleare Energieforschung (einschl. Reaktorsicherheit) | 950 680 | 902 467 | 495 787 | 217 231 |
| I1 Informationsverarbeitung | 26 756 | 56 356 | 83 230 | 85 586 |
| I2 Technische Kommunikation | 76 661 | 49 898 | 73 811 | 68 743 |
| I3 Elektronische Bauelemente | 86 332 | 114 050 | 142 748 | 144 059 |
| I4 Anwendung der Mikroelektronik; Mikroperipherik | 9 307 | 22 782 | 24 274 | 28 549 |

Key:—a.Supported area/support priority—b.Support in thousand DM—1=Basic research extending beyond individual programs—B=Special areas of basic research (in particular large equipment)—O1=Geosciences (in particular deep-well drilling)—**Sum total 1**—2=Long-term government programs—C1=Oceanography—D=Space research and space technology—**Sum total 2**—3=Quality of life (preventive research)—F1=Ecology research—F2=Technologies for preserving and protecting the environment—F5=Water research—F8=Safety research and safety technology—G=Research and development to promote health—H=Research and development to humanize the working environment—P2=Construction research and technology—W1=Cross-sectional activities (including evaluation of the consequences of technology—**Sum total 3**—4=Market-oriented technology support—C2=Oceanography—E1=Coal and other fossil energy sources—E2=Renewable energy sources and efficient energy use—E3=Nuclear energy research (incl. reactor safety)—I1=Information processing—I2=Technical communication—I3=Electronic components—I4=Application of microelectronics, microperipherals

Table II/17 (Continued)

| Profil Förderbereich/Förderschwerpunkt (a) | Fördermittel in TDM (b) | | | |
|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987[1]) |
| I5 Fertigungstechnik | 16 185 | 10 001 | 15 246 | 32 545 |
| K Biotechnologie | 22 948 | 26 665 | 42 824 | 36 391 |
| L1 Materialforschung | 53 600 | 51 269 | 60 407 | 74 844 |
| L2 Chemische Verfahrenstechnik | 6 950 | 6 000 | 5 366 | 5 599 |
| L3 Physikalische Technologien | 20 517 | 19 411 | 26 872 | 25 097 |
| M Luftfahrtforschung und -entwicklung | 65 629 | 61 691 | 61 313 | 69 336 |
| N Forschung und Technologie für bodengebundenen Transport und Verkehr (einschl. Verkehrssicherheit) | 183 842 | 166 440 | 172 137 | 197 693 |
| O2 Rohstoffsicherung | 34 350 | 24 523 | 11 370 | 8 339 |
| Summe 4 | 2 006 570 | 1 899 189 | 1 565 573 | 1 329 769 |
| **5 Rahmenbedingungen, Infrastruktur** | | | | |
| U Fachinformation | 2 731 | 4 271 | 7 232 | 9 263 |
| Insgesamt | 2 408 483 | 2 316 054 | 1 946 548 | 1 699 100 |

Key:—a.Supported area/support priority—b.Support in thousand DM—I5 =Manufacturing technology—K=Biotechnology—L1= Materials research—L2=Chemical process technology—L3=Physical technologies—M=Aviation research and development—N=Research and technology for ground transport and traffic (incl. traffic safety)—O2=Securing raw materials—**Sum total 4**—5.General conditions, infrastructure—U=Technical information—**Total**

[1]) As of 12-31-1987
Source: BMFT
Differences due to rounding

Table II/18 shows the trend in the percentage of funds provided for joint industrial projects for selected technology areas: While in 1984, joint projects in manufacturing technology received only 17 percent of the funds provided for private industry, in 1986, support funds went almost exclusively to joint projects (96.2 percent). The support approach "Joint Projects" was also used increasingly in the key areas of information technology and materials research and increasingly also in biotechnology.

Table II/18

Support Funds for Joint Industrial Projects as a Percentage of Direct Project Support for Private Industry--Selected Technical Areas --in percent--

| | 1984 | 1985 | 1986 |
|---|---|---|---|
| Manufacturing technology | 17.0 | 83.2 | 96.2 |
| Information technology (excluding manufacturing technology) | 21.3 | 55.3 | 70.6 |
| Materials research | 14.8 | 18.9 | 62.4 |
| Biotechnology | 48.7 | 55.4 | 55.3 |

Source: Federal Ministry for Research and Technology

Overall, joint industrial research showed a positive trend:

—The number of joint projects has increased considerably since 1984; in 1986, it consisted of 333 projects (1985: 265; 1984: 179);

—Approximately 60 percent of market-oriented technology support funds for private industry go to joint research (1986 approx. DM980 million);

—The number of joint projects increased considerably in particular in key areas such as information technology, manufacturing technology, biotechnology, materials research, and physical technology.

## EUREKA

The EUREKA initiative is also based on the joint research concept. EUREKA created a framework for European cooperation between companies and research institutions of different countries. Geographically, EUREKA includes all countries in Europe which are EC and EFTA members and Turkey. The topic of research activities is not predetermined by the governments; the project partners themselves determine across national boundaries how and with whom they want to cooperate on what topics.

Important examples for cooperation, where research across national boundaries promises considerable advantages, are PROMETHEUS, a project to develop traffic guidance systems in cars, and the environmental projects EUROTRAC (air pollution) and EUROMAR (pollution of the oceans). Administrations and policies try to support these activites wherever possible with appropriate measures—e.g. to remove trade barriers or to determine joint European standards. Companies in the Federal Republic of German participating in EUREKA are supported through project support for special programs—based on the generally applicable political principles governing research support. German companies participate in 50 of the 165 EUREKA projects (as of 12-31-1987); of these, 30 projects receive approx. DM600 million in support funds from BMFT (see diagram II/14), EUREKA shows to what extent creativity can be generated in private industry and science if a suitable framework for European cooperation is provided.

### Footnotes

1. Ifo-Innovation test 1986.

2. Source: Professional Association for Scientific Statistics GmbH, see table VII/16.

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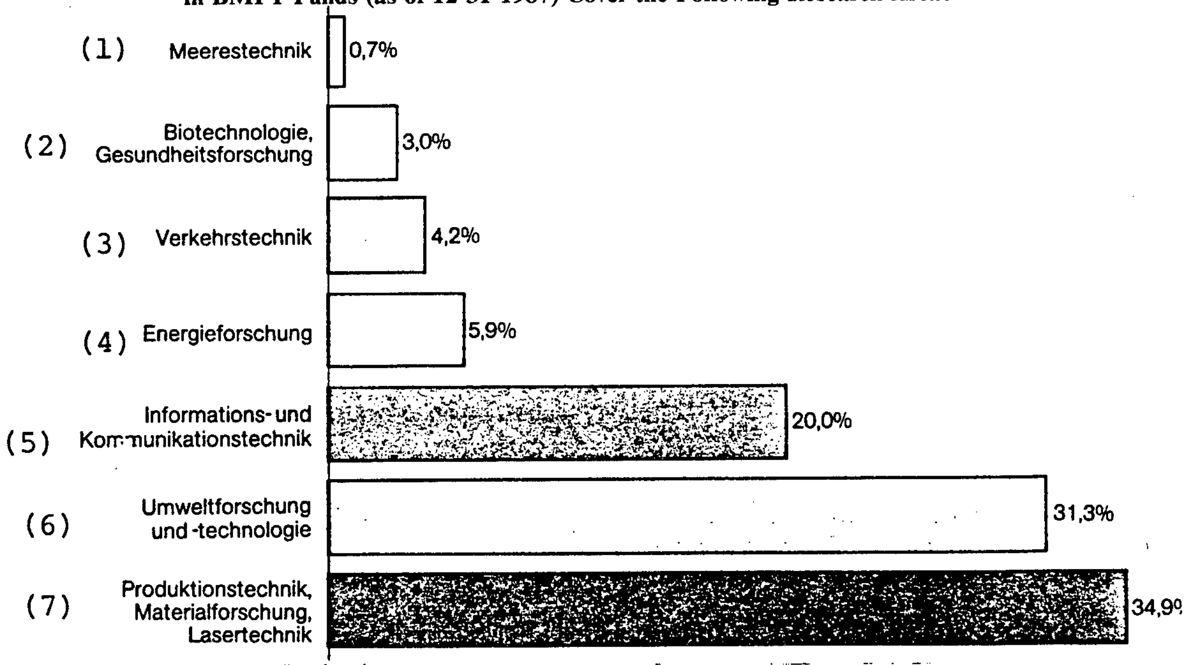
**Diagram II/14: EUREKA Projects Supported by BMFT. The 30 Projects Supported by ca. DM600 Million in BMFT Funds (as of 12-31-1987) Cover the Following Research Areas:**




Key:—1.Oceanography—2.Biotechnology, health research—3.Traffic engineering—4.Energy research—5.Information and communication technology—6.Environmental research and technology—7.Production technology, materials research, laser technology

**Table II/19: Federal Support for Non-Military Research and Development in Private Industry by Supporting Entities and Number of Supported Companies/Institutions, 1985 and 1986**

| (1) Ressort/Maßnahme | 1985 (2) Begünstigte Unternehmen/ Stellen der Wirtschaft | 1985 (3) Fördermittel/ Steuermindereinnahmen [1] | 1986 (2) Begünstigte Unternehmen/ Stellen der Wirtschaft | 1986 (3) Fördermittel/ Steuermindereinnahmen [1] |
|---|---|---|---|---|
| | Anzahl (4) | Mio DM (5) | Anzahl (4) | Mio DM (5) |
| BMFT (6) | | | | |
| – Direkte Projektförderung (7) | 955 | 2 318,9 | 1 028 | 1 950,4 |
| (darunter industrielle Gemeinschaftsforschung) (8) | (33 | 34,7) | (34 | 34,9) |
| – Sonderprogramm Mikroelektronik (9) | 542 | 18,3 | 4 | 0,06 |
| – Mikroperipherik (10) (indirekt-spezifische Maßnahme) (11) | 35 | 1,6 | 132 | 14,0 |
| – Fertigungstechnik (12) (indirekt-spezifische Maßnahme) (13) | 790 | 112,8 | 662 | 119,8 |
| – Biotechnologie (14) (indirekt-spezifische Maßnahme) (15) | – | – | 12 | 1,3 |
| – Forschungspersonal-Zuwachsförderung (16) | 335 | 1,7 | 2 320 | 40,3 |
| – Auftragsforschung und -entwicklung (17) | 1 354 | 41,0 | 1 656 | 51,8 |
| – Technologieorientierte Unternehmensgründungen (TOU) [2] (18) | 100 | 36,5 | 144 | 40,3 |
| – Forschungskooperation zwischen Industrie und Wissenschaft (19) | 106 | 2,9 | 261 | 10,9 |
| – Technologietransfer (20) | 1 | 0,2 | 2 | 0,5 |
| Summe BMFT (21) | | 2 533,8 | | 2 229,4 |
| BMWi (22) | | | | |
| – FuE-Personalkostenzuschuß (23) | 9 201 | 377,6 | 9 000 | 365,3 |
| – Förderung von FuE bei KMU in Berlin (24) | 49 | 8,0 | 37 | 8,4 |
| – Industrielle Gemeinschaftsforschung (25) | 93 | 94,8 | 94 | 96,8 |
| – Förderung der Entwicklung und Innovation im Steinkohlenbergbau (26) | 10 | 51,9 | 9 | 27,1 |
| – Zuschüsse zur Entwicklung ziviler Flugzeuge (27) | 3 | 363,4 | 3 | 344,9 |
| – sonstiges (28) | – | 1,2 | – | 0,3 |
| Summe BMWI (29) | | 896,9 | | 842,8 |
| **Übrige Ressorts** (30) | ... [3] | 114,3 | ... [3] | 105,6 |
| **Steuerliche Maßnahmen** (31) | | | | |
| – FuE-Investitionszulage (§ 4 InvZulG) (32) | ... [3] | 400,0 | ... [3] | 433,0 |
| – FuE-Sonderabschreibungen (§ 82d EStDV) (33) | ... [3] | 215,0 | ... [3] | 200,0 |
| Summe Steuerliche Maßnahmen (34) | | 615,0 | | 633,0 |
| (35) **Insgesamt** | ... [3] | 4 160,0 | ... [3] | 3 810,8 |

Key:—1.Department/measure—2.Supported companies/institutions in private industry—3.Support funds/reduced tax revenues [1])—4.Number—5.In million DM—6.Federal Ministry for Research and Technology—7.Direct project support—8.(including joint industrial research)—9.Special microelectronics program—10. Microperipherals—11.(Indirect specific measure)—12.Manufacturing technology—13.(Indirect-specific measure)—14.Biotechnology—15.(Indirect specific measure)—16.Support for research personnel increase—17.Contract research and development—18.Establishment of new technology-oriented companies (TOU)[2])—19. Research cooperation between industry and science—20.Technology transfer—21.Total BMFT—22.Federal Ministry for Economic Affairs (BMWi)—23.R&D personnel cost subsidy—24.R&D support for small and medium-sized companies in Berlin—25.Joint industrial research—26.Support for development and innovation in coal mining—27.Support for the development of civilian aircraft—28.Other—29.Total BMWI—30.Other departments—31.Tax measures—32.R&D investment grant (paragraph 4 of Investment Grant Law)—33.R&D special depreciation (paragraph 82d, Rule on Income Tax Implementation)—34.Total tax measures—35.Total

[1])*Reduced tax revenues for federal, state, and local governments*

[2])*TOU = phase II and III*

[3]) *No data*

Source: BMFT

Differences due to rounding

## Details on Government Funding for Institutes, R&D Topics

### Max Planck, Fraunhofer Societies; DFG

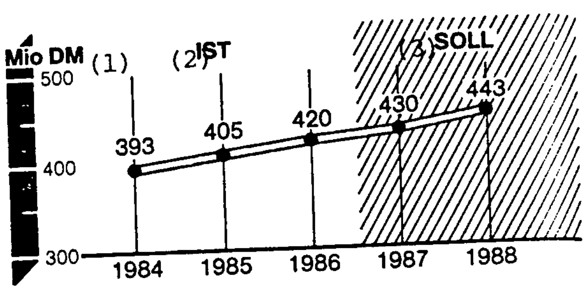
*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 122-123*

[Text]

**Basic Financing for the Max Planck Society**

The Max Planck Society for the Advancement of Science e.V. (MPG) is the supporter organization for about 60 institutions of basic research at present. It has been in existence since 1948 as the legal successor to the Kaiser Wilhelm Society founded in 1911. Its objective is unrestricted basic research of the highest quality in selected fields as a complement to university research (see in particular Part VI, Section 3.1). In recent years new emphases have been established, with the promoting of clinically oriented basic research through the establishment of Clinical Research and Working Groups for fixed durations, with the founding of Max Planck institutes in the fields of polymer research and social research, with participation in gene centers in Cologne and Munich, and with the reinforcement of important special fields such as quantum optics, immunobiology, and solid-state research. Within the period 1978 to 1987 this society set up a total of about 20 new research facilities (institutes, research and working groups). The elbow-room needed to set up these new establishments had to be created essentially through closures on a corresponding scale. For the year 1988 the Federal Government and the Laender raised the basic financing of the MPG proportionally more than average, by 5 percent. The opportunities for action by the MPG are to thereby be expanded.

The 1988 budget of the MPG (not counting the Max Planck Institute for Plasma Physics, which is being funded as a major research institution) runs to about DM1.035 billion, including DM97 million in project funds. The Federal Government and the Laender are covering DM907 million of this as public-institution assistance.




**R&D Expenditures of the Federal Government for MPG Basic Financing**

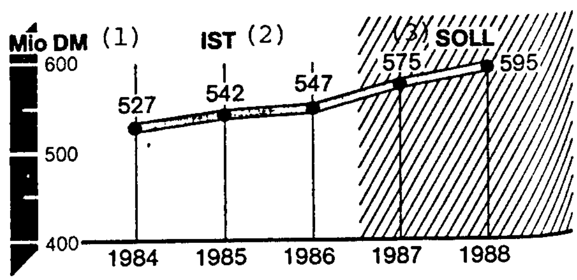
Key:
1. Millions of DM
2. Actual
3. Estimated

**Basic Financing for the German Research Association**

The German Research Association (DFG) (see also Part VI, Section 2.1), at the federal level under the overall responsibility of the Federal Minister of Education and Science (BMBW), is an independently administered organization of science that promotes above all university research in all disciplines of the humanities, mathematics, biological sciences, and natural sciences and engineering. In this connection the encouraging of the next generation of scientists is its special concern.

Its financial assistance is not only for individual research projects or major research programs, but also for promoting scientific librarianship, providing computing centers to the universities, and maintaining certain auxiliary research facilities such as the research ship "Meteor" and a central institute for animal experiments in Hannover. However, the DFG does not have ongoing supervision over such facilities.

In 1986 it had available about DM1.029 billion. Of this, the federal institutional share came to DM546.8 million in 1986.




**R&D Expenditures of the Federal Government for DFG Basic Financing**

Key:
1. Millions of DM
2. Actual
3. Estimated

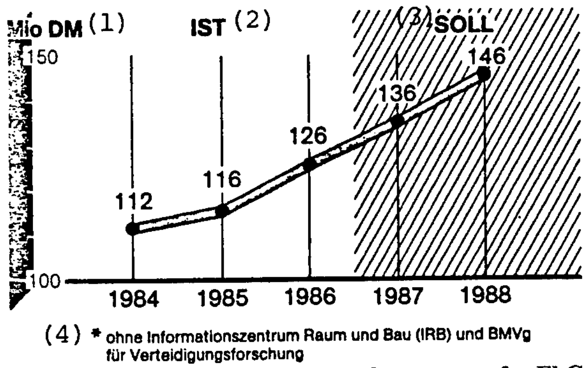
**Basic Financing for the Fraunhofer Society**

The Fraunhofer Society for the Advancement of Applied Research e.V. (FhG) is the supporter organization for 33 institutes of applied research and two service facilities (see in detail Part VI, Section 3.2). It offers its aid to enterprises in the economic sector and to governmental agencies in three fields:

1. Research conducted under contract,
2. Defense research,
3. Services.

In the performance sectors of contract research/services, the FhG operates according to the model of performance-dependent basic financing.

The FhG was able to substantially increase its contract research capacities, above all through an additional scheduled expansion in its newer institutes. Entities newly founded since 1984 are the Institute for Laser Technology in Aachen and the working groups for integrated circuits in Erlangen and for graphic data processing in Darmstadt. The 1988 economic plan of the FhG earmarks a total expenditure of about DM517 million.




**R&D Expenditures of the Federal Government for FhG Basic Financing***

Key:
1. Millions of DM
2. Actual
3. Estimated
4. *Not including Space and Construction Information Center (IRB) or BMVg [Federal Ministry for Defense] expenditures for defense research

## Aerospace

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 130-132*

[Text]

### 2.4 Space Research and Space Industry (Promotion Sector D)

The funding measures of the FRG, which are geared to new, large-scale, and long-range space activities, are concentrated on extraterrestrial research and observation of the earth, the development of applications satellites, the preparing of COLUMBUS orbital systems and the executing of SPACELAB missions, the completing of the booster rocket family ARIANE and the development of the manned space glider HERMES, general program preparation and support, new technologies, and activities in support of the industrial utilization of astronautics.

Important goals are:

1. Promotion of basic research by the space industry

2. Development of the space industry and the use of its results for innovations in the industrial sector, service sector, and administration

3. Strengthening the competitiveness of German astronautics companies and institutions

4. Promoting international cooperation, above all supporting European integration and continuing cooperation with the United States.

The emphases of the funding measures within the national and multinational (ESA [European Space Agency]) framework are:

1. Extraterrestrial research (astronomy, astrophysics, solar-terrestrial basic research)

2. Earth-oriented research on the status of the land areas, the atmosphere, the oceans, and the ice-covered areas of the earth (remote reconnaissance)

3. Development of radio, communications, navigational, and data relay satellites to the point of demonstrating their readiness for applications, introduction of operating systems by the users

4. Exploratory utilization of space as a laboratory for studies in materials science, process engineering, and biology-medicine, with the aid of the manned space laboratory SPACELAB and the recoverable space platforms EURECA and SPAS, as well as with high-altitude research rockets TEXUS and using mini-payloads with SPACESHUTTLE missions (MAUS [Autonomous Materials-science Experiments under Weightlessness])

5. Development and construction of the manned European space station system COLUMBUS

6. Improving European launch vehicle technology (ARIANE family).

An important new course in European space policy was set at the Rome conference of research ministers of the ESA member states on 30/31 January 1985. Here a decision was made to strengthen the scientific program of the ESA, to start on preparations for the two programs ARIANE 5 and COLUMBUS, and also to expand other activities of the ESA, above all the scientific program, by an annual increase of 5 percent up to 1989; the common goal of all of this was to ensure the independence and competitiveness of Europe in the entire space sector up to the end of this century (see also Part V, Section 2.2).

At the beginning of 1987 the Federal Government decided to support the joint European efforts for a commitment oriented to the long term in manned space travel. It welcomed the conducting of a corresponding coherent European astronautics program up to the year 2000 in the ESA and resolved that Germany would play a leading role. At the same time it came to decisions on

the scope of a corresponding German space program. With its resolution in January 1985 on preparing for the projects COLUMBUS, ARIANE, and somewhat later HERMES, the Federal Government had already established that German space activities are an important element of its foreign, economic, and technological policy, and are of far-reaching scientific-technical and economic importance as well as of great political significance to the FRG itself, to the independence of Europe, and to transatlantic cooperation.

On 9/10 November 1987 in The Hague, the ESA Council at the ministerial level agreed to carry out the development of ARIANE 5, COLUMBUS, and HERMES, thus giving a clear signal as to European space policy up to the year 2000 and beyond. For technical and programmatic reasons the development of COLUMBUS and HERMES is being carried out in two phases. The ministers likewise decided in favor of the continuation and further development of the user programs, especially those of telecommunications, micrograviation, earth observation, and extraterrestrial concerns. The orientation framework in this case is the proposal by the director general for a long-term program up to the year 2000, but at a lowered level of total costs. The Council's ministerial conference confirmed its interest in Europe's participation by way of COLUMBUS elements in the international space station program proposed by the United States.

The planned space-technology infrastructure will make it possible for Europe to substantially expand the areas of exploitation of space travel, including manned operations in space for laboratory operation as well as for maintenance and reequipping tasks. It promises an increase in flexibility, capability, and economic efficiency for the sake of the practical use of space-flight technology. Thus HERMES will be used principally for passenger transport, ARIANE 5 for commercial and large payloads. The central element of COLUMBUS, the free-flying laboratory MTFF (= man tended free flyer), will be serviced and operated by humans for a few days at a time, then will be operated automatically and by remote control for several months. Both types of operation will provide important experiences for assessing which space travel scenario will be able in the relatively long run to give a conclusively satisfactory cost-benefit ratio.

The large expenditures for the space-technology infrastructure, which in the coming decade will make up more than half of the funds planned for the ESA, can be defrayed only by way of an exceptional joint European effort. But as an investment in the future for German and European science and economy, these expenditures will provide access to the new technologies of the space industry that will be available in the next century. Associated with these decisions is the option of having an independent European access to space with the possibility of utilization of the space industry in all sectors.

The promotion of basic extraterrestrial research is an accepted long-term task of the nation, one which is characterized by a balance of programs and by continuity. The results obtained in the last 10 years in basic extraterrestrial research can be described as peak achievements compared to the international state of the art. The FRG has achieved a prominent status, for example, with the exploration of interplanetary space by means of the solar probes HELIOS A and B and with the exploration of the comet HALLEY using the comet probe GIOTTO of the ESA.

Projects are being carried out in the following research areas:

1. Astronomy and astrophysics
2. Solar-terrestrial relationships
3. Biomedicine
4. Applications satellites
5. Orbital systems, space laboratory SPACELAB, space platform EURECA, space station elements COLUMBUS
6. Launch vehicle ARIANE
7. Space glider HERMES as a new manned reentry system.

In general the high costs and risks entailed in the development and market introduction of space technologies and systems cannot be borne by industry alone right from the beginning. But in certain subareas industry is already playing an autonomous role. For example, in the case of communications satellites a growing commercial market has formed, which now needs governmental help only in a subsidiary fashion in special new technological sectors. However the exceptional nature of this market needs governmental participation in the commercialization of the products of the industry. In the case of weather satellite operating systems, government users are procuring space vehicles for public services without support from research and development programs. Production and marketing of the ARIANE, including launching services, were assigned to the European business enterprise ARIANESPACE, which has arrived at a substantial share of the world market.

Satellite-based earth exploration for more accurate mapping of the continents and oceans and in order to obtain data for weather forecasting and information above all on mineral resources, bodies of water, and vegetation, as well as for observation and monitoring the environment, is already becoming increasingly attractive to commercial users.

The industrial use of astronautics to an economically significant extent for research and production is only at the beginning stages. In the industrial countries involved in astronautics private-enterprise associations of interests are forming both on the supplier side among the aeronautics and astronautics companies and also on the demand side outside the aerospace industry and in the service branches. Above all for materials-technology innovations and for medical-pharmaceutical-biotechnological processes, especially given the almost absolute weightlessness obtainable in flights with high-altitude research

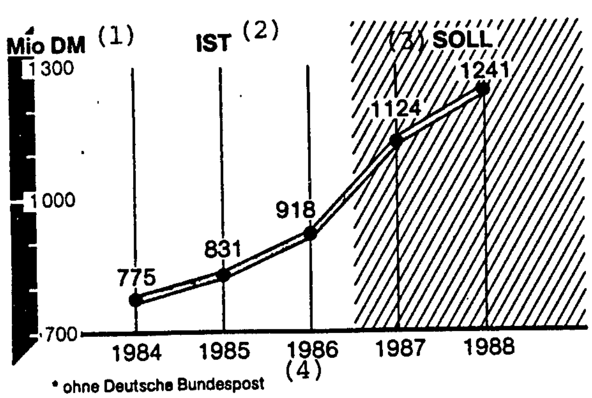
rockets (TEXUS), in SPACESHUTTLE missions carrying mini-experiment containers (MAUS) and in using the space laboratory SPACELAB, this is already providing initial possibilities that will achieve a new dimension for research and possibly for certain selected products when a permanently manned space station is built in the 1990's.

National astronautics activities are to a large degree intertwined with international cooperative ventures. Therefore participation in the program of the ESA is as much as ever an important element of the German space program. In addition transatlantic as well as other bilateral cooperation (for example with the United States, France, Great Britain) has paid off, but national capability is a prerequisite for acceptance and the possibility of an involvement on a partnership basis that is balanced in its give and take.

Up to now the bulk of the funds for European Community programs and international projects in research and technology—about two thirds—have been provided from the budget of the Federal Minister for Research and Technology (about 80 percent of the national activities are bound up in bilateral or multilateral projects). An overview of the breakdown of the planned appropriations for space expenditures by the BMFT in 1988 is shown in the following graph.

In addition, the following monies from the separate fund of the Federal German Postal Service can be designated as going into the radio satellite TV-SAT: 1984 to 1987, about DM80 million for terrestrial facilities, from 1984 to 1987 about DM140 million for the space component.

The total capital expenditures of the Federal Postal Service for national satellite projects and involvements in international satellite systems, inclusive of the relevant terrestrial facilities, come to about DM750 million in the 1986 fiscal year.




**R&D Expenditures of the Federal Government* for Space Research and the Space Industry**

Key:
1. Millions of DM
2. Actual
3. Estimated
4. *Not including the Federal German Postal Service

## Information Technology

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 149-151*

[Excerpts]

### 2.9 Information Technology; Manufacturing Technology (Funding Sector I)

#### Information Processing

In recent years information processing has been one of the most reliable growth factors in information technology. It is generally expected that it will retain its character as a growth branch for at least the medium term.

Despite noteworthy growth rates and despite a not unfavorable technological starting position, the share held by German manufacturers in the world market is relatively small.

The R&D funding measures of the Federal Government are aimed at developing new technologies especially through basic research, and thus at strengthening the technological basis of the German data-processing industry in the future.

In the past the promoting of data processing or information processing was geared primarily to direct funding of R&D projects. Following the switching of funding towards collaborative projects begun in recent years, in 1987 only these sorts of projects were assisted, in order to achieve a stronger concentration on important research topics, to have a cooperative effort among several research partners, and to better effect transfers from research to industry.

The following activities of computer-oriented research were promoted in line with the government report Information Technology of March 1984, under the comprehensive designation Information Processing:

—1. The activity "Computer-aided Design of Computers and Software" includes on the one hand the development of simulation tools and testing tools for designing computers, and on the other hand the sector of software technology. In both areas the computer as an aid to designing and development is indispensable in order to cope with the complexity of hardware and software. Here, collaborative research permits an approach to the standardization of previous results in software technology.

—2. The work being done within the framework of the activity "New Computer Architectures" aims at new types of computer systems of very great power (for example, for the simulation of solutions to technical and

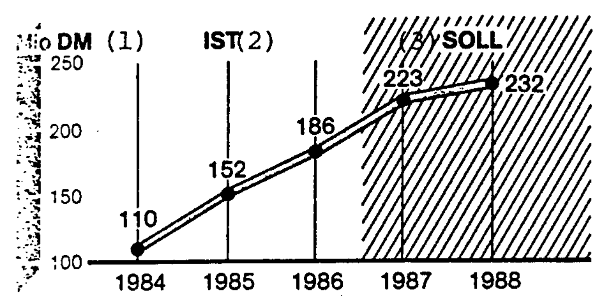
scientific problems) or at systems for special tasks (for example, in image processing). Two firms plus the major research institution GMD [Association for Mathematics and Data Processing] have founded the SUPRENUM Company mbH for the joint development of a supercomputer. In an initial development step a preliminary prototype was designed and its capability was demonstrated.

—3. The activity "Pattern Recognition" is to push forward with the automatic identification and analyzing of voice and image. The main emphasis here is the automatic recognition of normally spoken speech for the sake of an improved human-computer dialogue, and the recognition of objects and scenes recorded by a camera for use in future road vehicle steering systems.

—4. In the activity "Knowledge Engineering" the emphasis is on so-called expert systems. This has to do with one of the most important subareas of the new scientific field "artificial intelligence" and involves a large proportion of basic research. Funding is concentrated on advances with respect to basic problems such as the representing of knowledge in the computer (knowledge representation), natural-language dialogue capability (for the written German language), inference procedures, and more advanced systems of tools for constructing expert systems. These should lead to important developmental steps needed for the leap from data processing to knowledge engineering.

In addition the German Research Association is being given special financing for research work in the subject areas of the first and fourth activities for the purpose of reinforcing basic research at universities.

As for international activities, the EC's data processing program and ESPRIT [European Strategic Program for Research and Development in the Field of Information Technology] programs I and II, the "German-Japanese Forum on Information Technology," and the cooperative effort with Israeli research institutes can be mentioned.




**R&D Expenditures of the Federal Government for Information Processing**

Key:
1. Millions of DM
2. Actual
3. Estimated

## Telecommunications

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 151-153*

[Text]

**Technology-based Communications**

The telecommunications sector is undergoing a far-reaching technological upheaval. Digitalization and optical communications engineering on a glass-fiber basis are creating the foundations for a sweeping modernization of the public telecommunications networks and at the same time are offering the possibility of a whole new range of communications services.

At the same time, in all the industrial countries activities that are information and communication intensive are increasing. Many people speak about a trend toward an information society. An information society of the future is vitally dependent on high-capacity telecommunications networks. These represent the indispensable transport infrastructure for the growing flows of information. Thus telecommunications is becoming one of the most important formative tasks of the government for the future. To deal with this a significant reinforcing of the associated basic research is needed. This is being done within the framework of the subprogram Technology-based Communications in the government report Information Technology, which is being executed jointly by the BMP [Federal Ministry for Posts and Telecommunications] and the BMFT [Federal Ministry for Research and Technology].

The promotional measures of the BMFT are concentrated on the following areas:

*—1. Optical communications*

Funding for the basic technologies of components of optical communications engineering inclusive of broadband circuitry, for example glass fibers, lasers, diodes, switching networks, circuits, codecs.

With the project work already carried out the technological prerequisites were created for permitting an increased use of glass-fiber cables in the expansion of telecommunications infrastructures on the part of the German Federal Postal Service.

*—2. Integrated optics*

The long-term goal of research and development work in the field of integrated optics is to create the technological foundations for optical signal processing. Today, optically conveyed information must first be converted into electrical signals before it can be further processed by electronic processors. The steps in the realization of this are

- Development of integrated optoelectronic components—that is, integration of electronic and optical processing elements on a semiconductor substrate ("optical chip")

- Research work in the field of optical signal processing and the optical computer.

To this end, basic work has begun at the Heinrich Hertz Institute for Communications Engineering in Berlin (HHI), which also includes the building of a technology laboratory. These activities are to increasingly evolve into work toward the development of an optical signal relaying in cooperation with industry.

*—3. System engineering*

The utilization of the expanded telecommunications infrastructure and the standardization of new telecommunications services necessitate increasingly more joint work by telecommunications and entertainment electronics in the field of pre-normative research. The funding is above all for European collaborative projects (EUREKA) [Initiative for Increased Technological Cooperation in Europe] for working out new European standards:

- Preparations (definition phase) have been made for the execution of a EUREKA project on the digitalization of VHF radio.
- To support activities involved with information display the BMFT together with the Land of Baden-Wuerttemberg has established at the University of Stuttgart a center for the development of TFT [carrier telephony] controlled LCD's [liquid crystal displays] ("Display Institute").
- In video engineering the emphasis is on work to develop a uniform standard for the digital magnetic-tape recording of moving images (digital video recorder).
- By means of the HDTV collaborative project (HDTV = high definition television), the prerequisites are to be developed for a new television standard (wall television, 3-D television).

*—4. Data Communication*

The central emphasis is the R&D work on constructing the German Research Network (DFN). This collaborative project is being handled via the DFN Association founded in 1984. Prominent firms, universities, and research institutions are the members of this DFN Association. The DFN Association also has the task of preparing for and taking over the operation of the network. The initial communications services have been realized and introduced.

*—5. International Activities*

Since 1987 the EC Commission has been carrying out the European assistance program RACE (R&D in Advanced Communication Technologies in Europe). For this purpose it has earmarked 550 million ECU for the years 1987-1991. In addition to research work on developing technologies for transmission and relaying in broad-band networks, also being promoted is work on standardization and on realizing future communications services within an integrated broad-band network.

The emphases in the BMP funding are in particular:

*—1. Precursor Broad-band Network (VBN)*

Creation of the technical prerequisites for an experimental network for broad-band personal communication in the direct-dial mode via glass fibers for interested subscribers. This precursor broad-band network is being materialized within the glass-fiber overlay network, which connects 29 localities by glass-fiber transmission systems. At the end of 1987 about 380,000 fiber kilometers were in the network of the DBP [German Postal Service].

*—2. Video Communication*

Broad-band video communication as

- video conferencing from public and private video conference studios, and as
- applications-related moving image transmission (MEDCOM, and so forth),

which from 1988 on are to be handled within the VBN (see above).

*—3. Berlin Communication System*

The Berlin Communication system (BERKOM) is a project in the Berlin area with the following objectives:

- Construction of a testing and reference network in glass-fiber technology as a prototype for a future Integrated Broad-band Telecommunications Network (IBFN)
- Development and technical testing of new telecommunications services and technologies for a future broad-band telecommunications network (ISDN-B, [Integrated Service Digital Network-B], IBFN)
- Funding of scientific work in Berlin in the fields of informatics, communications technology, and telecommunications
- Elaboration of decision-making aids for the strategic planning of the German Postal Service with respect to IBFN and ISDN-B
- Promoting of innovation-oriented informatics and telecommunications industries.

*—4. Glass Fiber Transmission Systems*

Field tests in Berlin to determine the capability of single-mode fibers; investigation of the largest possible repeater spacings for transmission speeds of 565 Mbits/s.

*—5. Picture-phone Service in the ISDN*

Development of working models for the creation of a new picture-phone service in the ISDN.

*—6. SPREIN*

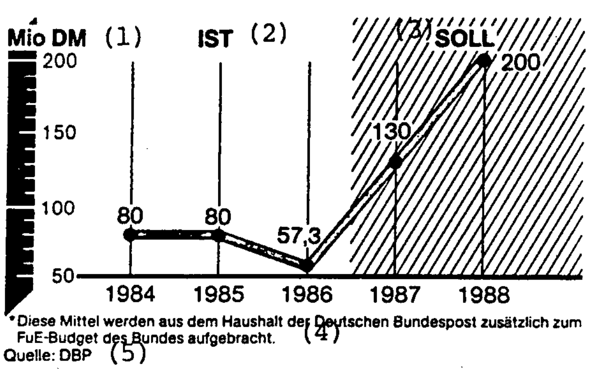
Development and testing of a voice recognition unit as well as a dialogue processor, with the aid of which a limited number of telephone subscribers can directly place orders in a mainframe computer of a mail-order company by means of voice input and can see the results of this process through the same medium. With this system experiment the German Postal Service is continuing forward with its intention to advance the development of voice processing.

*—7. Mobile Phone*

Subsequent to a German-French initiative which Italy and Great Britain later joined, within the overall framework of the Conference of European Administrations for Posts and Telecommunications (CEPT) the standards were developed for a future Europe-wide digital radiophone network. On 25 June 1987, upon a recommendation by the Council the EC member states agreed on the coordinated introduction of this technology in the Community as a Europe-wide public digital mobile radio service and approved of a guideline on the distribution of the frequency bands required for this purpose.

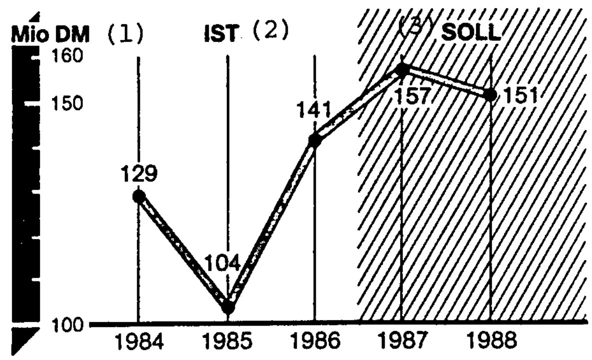
*—8. Communications Research at the Research Institute of the German Postal Service*

This pertains to in-house communications research at the Research Institute of the German Postal Service located in the Central Telecommunications Office in Darmstadt (see in detail Part VI, Section 6.10.1) on the




**R&D Expenditures of the German Postal Service for Telecommunications***

Key:
1. Millions of DM
2. Actual
3. Estimated
4. *These funds are provided from the budget of the German Postal Service in addition to the R&D budget of the Federal Government
5. Source: DBP




**R&D Expenditures of the Federal Government for Technology-based Communications**

Key:
1. Millions of DM
2. Actual
3. Estimated

manufacturer-independent, scientifically-based assessment of engineering and technological developments. New emphases are high definition television (HDTV), optoelectronic components (integrated optics), and making new frequency ranges accessible to mobile and satellite radio.

## Electronic Components

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 153-155*

[Excerpts] The technological upheaval in electronics exceeds in extent and rapidity that of most other technologies, and in the recent past has accelerated even more. The assistance measures of recent years have concentrated on the following subareas of microelectronics:

*—1. Process technology*

The industrial manufacturing of highly integrated circuits will have reached the limits of light-optical lithography methods by the end of the 1980's. The developmental expenditure for process technology as well as the investment and operating expenditures for the assembly lines are continuing to increase rapidly and are beginning to exceed the powers of even large individual manufacturers.

The cooperation necessary because of this cannot remain limited to the national setting, and accordingly the MEGA project is being worked on jointly by Siemens and Philips, with the Dutch government being involved in the funding. Initial successes have been presented to the public.

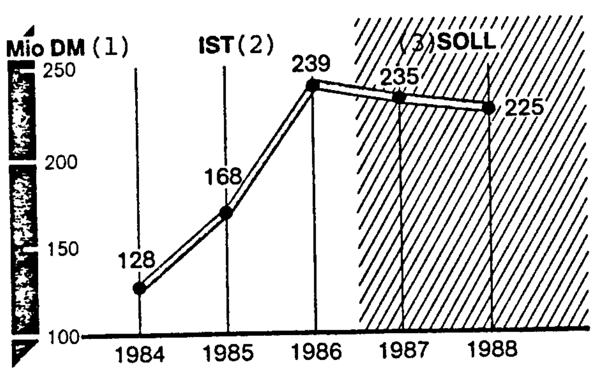
The "Submicron Collaborative Project" is looking beyond the limits of light optics; this is a joint effort by industry and research institutions aimed at creating the

necessary conditions for the process technology of the next decade. X-ray lithography is the favored structurization method. The objectives of this collaborative project are the development and assessment of manufacturing processes in submicron technology, the description, in terms of models, of the manufacturing process and the corresponding component structures, and demonstrating the workability of certain important functional units in applying this technology.

—2. *Materials and foundations*

The requirements of the electronic components industry make it necessary for its material basis to be steadily further developed. Promotional activities here embrace development and use of basic testing procedures for the investigation of material properties and how they are influenced, and the development of new materials and methods, especially for the field of compound semiconductors and for epitaxial crystallization (oriented overgrowth of thin crystalline layers on a crystalline substrate).

The project activities in several collaborative projects on the main field of "gallium arsenide" (GaAs) are advancing on schedule. Overall coordination is being handled by the Fraunhofer Institute for Applied Solid-state Physics.




**R&D Expenditures of the Federal Government for Electronic Components**

Key:
1. Millions of DM
2. Actual
3. Estimated

### Microperipherals

For the sake of ensuring competitiveness for the long term, an internationally competitive know-how basis must be created for the technologies involved in future microperipherals components. To this end a timely and close cooperation between research and industry is necessary.

Therefore within the framework of the government report "Information Technology" a new promotion emphasis "Microperipherals" (1985 to 1989) was decided on. This includes the following measures:

—1. Development of Modern Microelectronics-compatible Sensors (indirect-specific assistance)

This measure focuses on a broadly effective funding of the development of modern microelectronics-compatible sensors with an intelligent, integrated signal preprocessing. At the same time the aim is to encourage an accelerated broad-scale use of modern miniaturization technologies that have reached the application stage and are necessary for this development (semiconductor, thin-film, thick-layer, hybrid, and surface mounting technologies). With its simplified procedures for accepting and handling applications for funding, this measure is intended above all for the small and medium-sized sensor manufacturer.

By 30 June 1987, the end of this measure's period for filing applications, just under 700 applications had been filed, with 79 percent of these applications coming from relatively small firms having less than 500 employees.

—2. Promotion of Futuristic Technologies for Microperipherals

Assistance is being given to collaborative projects involving research and development activities dealing with overarching problems, with such activities being characterized by a high development risk, great financial expenditure, and a common interest on the part of several users in the know-how to be worked out.

Points of Emphasis:

- Micromechanics for sensors
- Integrated optics for sensors
- Technologies for chemical sensors
- Basic technologies for modern power components
- New materials for semiconductor donors
- Materials and technologies for construction and interconnection methods
- Basic work on interdisciplinary problems of microperipherals (for example, interfaces).

—3. Technology Transfer

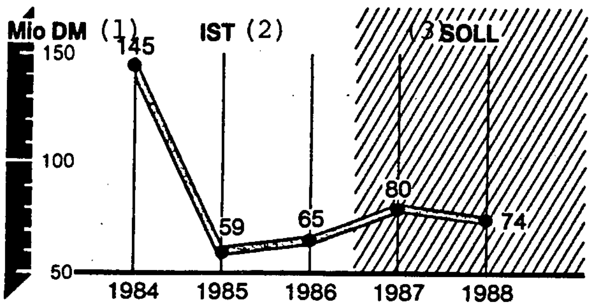
In addition to the indirect-specific funding, measures aimed at the transfer of technology are intended to accelerate the introduction of new technologies among small and medium-sized sensor manufacturers. Examples of this are:

- In connection with the project executor VDIS/VDE [Association of German Engineers/Association of German Electrical Engineers] Technology Center for Information Engineering GmbH, Berlin, ongoing

activities to promote technology transfer (publications, workshops, seminars, professional discussions, participation in trade fairs)

- Establishment, with federal funds, of one thick-film laboratory each at the Fraunhofer Institute for Solid-state Technology in Munich and at the University of Bochum, and of one thin-film laboratory each at the Fraunhofer Institute for Physical Test Methods in Freiburg and at the Technical University of Hamburg-Harburg, which among other things conduct training courses for employees of small and medium-sized businesses.

The measures for technology transfer are to be further pursued even more. Moreover attention will be directed especially toward seeing that the technologies developed in the sector "Futuristic Technologies for Microperipherals" are exploited as soon as possible by small and medium-sized firms.




**R&D Expenditures of the Federal Government for Applications in Microelectromids; Microperipherals**

Key:
1. Millions of DM
2. Actual
3. Estimated

## Biotechnology

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 158-164*

[Excerpts]

### Biotechnology (Funding Sector K)

Because of its great potential for innovations, biotechnology is accorded a key role in economic development similar to that of microelectronics and information and communications technology. In almost all the industrial nations, research capacities in public institutions and in industry are being expanded or newly created and accompanying governmental funding measures are being carried out. The Federal Government as well views the potential opened up especially by more recent biological research on a molecular-biology level as a great chance and at the same time a challenge for research as well as for promising innovations in the economy. Thus the application of biotechnical methods and the introduction of biotechnical products are proving capable of supporting agriculture by making its production more inexpensive, easier on the environment, and more improved in quality, and by opening up not only to agriculture but also to the chemical industry new fields of activity and market opportunities.

### Funding Program "Applied Biology and Biotechnology" (1985-1988)

In July 1985 the Federal Government made public a new funding program on "Applied Biology and Biotechnology" and thus defined the scope of increased assistance to biological and biotechnical research in the FRG.

The goal of all biotechnical procedures is to optimize certain normal metabolic and biochemical outputs of biological systems and to exploit them industrially under economically favorable conditions. In addition to entire plants and animals, also suited to this are above all microorganisms such as bacteria, yeasts and other fungi, to a limited extent single-celled algae, and—in the future—cell and tissue cultures of higher plants and animals. Also the synthesis potential of enzymes, which is assuming increasing importance in substance conversion within and outside the cell, is opening up important and new applications. This significant symbiosis between biology and process engineering is providing a great opportunity to expand the availability of natural substances and thus to contribute to the more efficient utilization of our resources.

New biological methods such as genetic engineering or cell-culture engineering as well as more recent developments in biological process engineering and enzyme technology are helping biotechnology to rapidly develop. The funding measures of the Federal Government are aimed at helping to deepen biological findings through broadly designed basic research, to improve the prerequisites for innovations that build on these findings, and to exploit the future opportunities contained in them. Thus the Federal Government is creating the basic research-policy and economic conditions needed for an improved exploitation of the manifold application possibilities of biotechnology—from agriculture to nutrition, the environment, health, and up to the recovery of raw materials and energy. Research in the field of biotechnology is being funded especially by the BMFT, but also by other federal ministries (for example, BML [Federal Ministry for Nutrition, Agriculture, and Forests] and the BMJFFG [Federal Ministry for Youth, Family, Women, and Health].

The assistance program of the Federal Government is intended to appreciably advance on a broad front both basic research and economic and technological development, in an interlinking of the actions of the federal ministries with the activities of the federal Laender, research promotion organizations, and industry. An overview of the assisted projects is given in the annual

report on the assistance program "Applied Biology and Biotechnology," which can be obtained from the Karlsruhe Technical Information Center, 7514 Eggenstein-Leopoldshafen.

**International Activities**

The Federal Government is aware that international cooperation in biological research is assuming a growing importance. It has planned its funding accordingly.

The goal of cooperation with industrial countries is to mutually utilize the scientific-technical know-how existing in the respective partner countries in order to jointly develop biotechnological procedures or products while economizing on time and resources. This includes, among other things, the exchanging of scientists, which not only serves to impart special knowledge but also should improve the transfer of the methods and techniques learned in the host country.

Cooperation with emerging countries and countries of the Third World serves the purpose of transmitting, to some extent, advanced biotechnological procedures and methods to these countries, the goal being not only scientific-technical aid but also the opening up of new markets for scientific-technical and industrial facilities of biotechnology. At the same time possibilities arise for using in a biotechnically processed form the biological raw materials present to some extent in these countries.

These include above all the countries of Egypt, Brazil, the People's Republic of China, India, and Indonesia. Measures for the training and further education of guest scientists within the framework of bilateral cooperation projects are considered to be the prerequisite for jointly working on the following points of main effort:

Biotechnological work on environmental pollution prevention and waste management, work on the diagnosis and treatment of specific tropical diseases in animals and humans, and work on optimizing agricultural production with an accompanying foodstuffs technology.

This cooperation with developing countries is intended to lead to the economic development of the cooperation partner through a transferring of elementary biotechnical procedures. Within the framework of the BMFT program "New Technology for the Third World," the elaboration of a detailed biotechnology concept is being planned, with support from the "Working Group for Tropical and Subtropical Agricultural Research."

Biotechnology is also the object of promotion by the Commission of the European Communities, as one of the action policies within the general program for 1985 to 1989. The program (action policy) "Research and Training in the Field of Biotechnology," which is endowed with a fund of 55 million ECU, is divided into the subject areas of research infrastructure and project assistance in fields of basic biotechnology. The EC biotechnology program aims at strengthening the infrastructure for biotechnological research in Europe, and together with the precursor program "Molecular Biology Engineering" (1982-1985) has improved cooperation among the member states of the European Community.

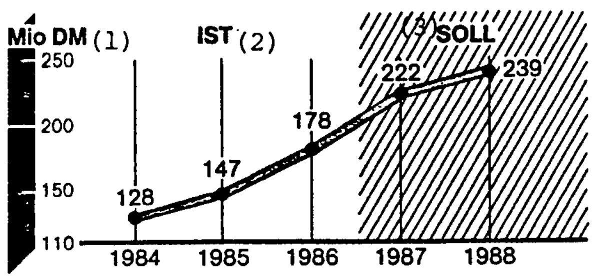
In connection with problems of Community interest and on transnational questions, European cooperation within the EC's biotechnology program could certainly be deepened even more (environmental biotechnology, safety research). The measures on exchanges of scientists begun within the framework of this program are very welcome; from the German viewpoint a further strengthening and expansion of the program is desirable here, since this can be viewed as a basis for future cooperative efforts.

The measures on reinforcing the infrastructure in the sector of biotechnical research should also be judged as deserving of improvement. In the German view a coordinated approach within the European Community is the best way to strengthen European research in this highly competitive field of a key technology and to keep within bounds the dependence of European research on extra-European institutions.

At present the Commission of the European Communities is preparing a follow-up program for the promotion of biotechnological research in the Community ("BRIDGE," 1990-1994) and a new research program (action policy) on the biotechnological development of the agricultural economy (ECLAIR," 1988-1993). The objective of "BRIDGE" is to make a cross-utilization [? "Ueberbenutzung": possibly typo for "Ueberbrueckung"—bridging] between the fields of biological science and the biological industry in which its knowledge is technically exploited; with the program "ECLAIR" the possibilities of the technological utilization of agricultural raw materials and the environmental effects associated with their recovery are to be studied.

The FRG is involved in the European Molecular Biology Laboratory (EMBL) in Heidelberg, together with 10 other West European states and Israel. The main emphases of this scientific program are structural and cellular biology, morphogenesis, genetic structure and gene regulation. The function of the EMBL as a European training and advanced education facility for scientists was expanded some time ago to include doctoral candidates. The branch facility of the EMBL at the German Electron Synchrotron (DESY), which in the past concentrated above all on detector developments and work in protein crystallography and X-ray spectroscopy, has been given a great impetus through the growing importance of X-ray synchrotron radiation. With this Hamburg branch the EMBL has available to it for the coming years an experimentation facility unique in Europe with respect to providing arrangements for X-ray synchrotron radiation for biological and biochemical purposes.

The EMBL is acknowledged to be doing top-class work internationally in the investigation of biological structures and dynamic biological processes, especially in the field of membrane biology; recently its work in the field of virus research and above all leukemia research has also become well-known. Likewise familiar is the nucleotide sequence bank (DNA sequence bank) and a cryoelectron microscope, the only one available in Europe. Efforts are being made to expand the existing data banks to include protein sequences, a chromosome file, monoclonal antibodies, and so forth. Cooperation between the EMBL and German research institutions and German industry is extensive: Thus, for example, workers at the EMBL periodically give lectures at the University of Heidelberg and conduct practical laboratory courses and seminars there. There is also energetic cooperation in scientific instrument development between a number of working groups in the EMBL and German firms.




**R&D Expenditures of the Federal Government for Biotechnology**

Key:
1. Millions of DM
2. Actual
3. Estimated

## Advanced Materials

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 164-166*

[Excerpts]

### 2.11 Materials Research; Chemical Process Engineering; Physical Technologies (Funding Sector L)

### Materials Research

The materials research program begun in 1985 is being very successfully put to use by industry and science. Because of the fundamental importance of raw and industrial materials to almost all the new technologies, materials research is one of the most important prerequisites for maintaining and increasing the competitiveness of our industry.

The funding measures are concentrating on a few classes of materials and technologies that have been selected on the basis of their potential technical and economic importance in light of the present state of the art in the FRG. The objects of the program are both structural materials of an inorganic nature (metals, non-metals, ceramics, glasses) and also structural and functional materials of an organic chemical nature (polymers).

The materials research program takes as a basis the principle that a primary task and responsibility of businesses is to create through research and development the necessary conditions for future competitiveness. The planned funding measures aim above all at mobilizing the scientific and technical potential of highly qualified research groups in the institutions of basic and applied research together with the potential of industry for the purpose of solving selected R&D tasks.

The tool of collaborative research has proved to be eminently successful, given the necessary interdisciplinary connections between basic research and industrial development. Through cooperative teamwork based on a division of labor, collaborative research offers the greatest prospects for achieving the program's long-term and ambitious objectives.

In detail, the following main fields are to be promoted:

### Ceramics

A general development goal is making available practically dependable ceramics and components with a high capacity for industrial use. For new heavy-duty ceramics numerous areas of application are emerging in general machine building, engine construction, apparatus engineering, chemistry, and metallurgy.

The negative properties that have hitherto limited their use are to be improved above all. In particular the aim is to alter the brittleness of ceramic materials in a positive way via the selection of suitable starting materials, increasing purity, selective doping, and the generation of special grain structures with small grain-size distributions.

We must achieve new combinations of materials, very pure materials, and well-definined grain structures, which for their part presuppose new methods, and better techniques for powder production, densification, shaping, and solidification of the powder. A clarification of microscopic failure mechanisms is needed in order to be able to use ceramic materials with a risk that can be calculated; hitherto, structural parts made of ceramic materials have failed abruptly and unpredictably, in contrast to metals. The work in this field now being done in the form of collaborative projects set up on the basis of a division of labor between industry and scientific institutes is being supplemented by a point-of-main-effort program, called "Heavy-duty Ceramic Materials," of the DFG [German Research Association], which began on 1 January 1988 and is being financed by the BMFT. The goal of this main-effort program is to encourage chemists, physicists, ceramicists, mineralogists, materials scientists, and also process engineers and

materials testers to undertake joint fundamentals-oriented projects, since in most cases their differing ways of thinking, methods, and experiences can contribute considerably more effectively to the solving of problems in an interdisciplinary cooperative effort than in each discipline on its own. The scientific goal is to explore more deeply the processes needed for the manufacturing and characterization of ceramics with well-defined properties and to explore the interrelations of material microstructure and macroscopic properties.

**International Cooperation**

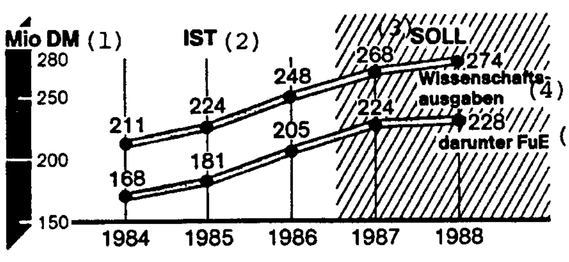
The FRG is cooperating with other industrial nations in certain fields of materials research. We can mention here in particular:

1. Cooperation with the United States for the development of standardized testing methods for heavy-duty ceramics

2. Cooperation with Israel in the areas of polymer research, composite materials development, and powder metallurgy

3. Cooperation with France, Great Britain, Spain, and other European states within the research initiative "EUREKA." Here certain cooperation projects have taken shape that transcend European borders, whose goals can be achieved the most effectively by working together on the basis of a division of labor on the part of the European partners involved, such as the development of high-powered welding processes for aluminum materials or the development of laser-strengthened ceramics for use in diesel engines

4. Participation of German partners (industry and institutes) in European collaborative projects of the programs BRITE [Basic Research in Industrial Technologies for Europe] and EURAM [European Research for Advanced Materials].




**Expenditures of the Federal Government for Materials Research**

Key:
1. Millions of DM
2. Actual
3. Estimated
4. Expenditures for science
5. R&D portion

## Physical Technologies

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 168-170*

[Excerpts] Objectives in the field of physical technologies are:

1. To examine results of physics research for their industrial exploitability (analysis of future technologies)

2. To translate technologies with an economic potential into industrial realization (promotion as pump priming)

3. To actively and systematically disseminate R&D results obtained (technology transfer)

4. To analyze in a timely fashion impediments to the development of technologies and to give suggestions on eliminating them (technology consequences assessment), and

5. To analyze the effect of funding with respect to its technical-economic efficiency (evaluation of funding activities).

Through a search and evaluation process, incipient technologies are being promptly studied and assessed. Here the search field from which technology candidates are to be identified in timely fashion essentially consists of areas of physics research.

The analysis and assessment phase at present includes the following new scientific problems and technologies:

- Nonlinear dynamics,
- Nonlinear optics,
- Clusters,
- Ultrasound of extremely high power,
- Free-electron lasers.

Assistance within the physical technologies is concentrated on those technological fields that can be expected to be of relatively broad industrial importance. These subareas are being funded selectively and directly for a limited period—about 5 years—with collaborative projects between scientific institutions and businesses being given priority.

At present the following fields are being promoted especially in this sector:

1. Surface and Thin-film Technology

Development of new methods and equipment for surface treatment and surface coating (physical and chemical vapor deposition methods, ion beam techniques, plasma-based and laser-based processes), with a view to economical manufacturing, increasing the quality, functional reliability, and useful life of products while saving

on raw materials and energy, development of new fundamental methods, measuring techniques and equipment for surface and structural analysis (imaging, element-specific, metrological methods), taking advantage of new applications of surface techniques, and development of innovative products.

These activities led to the drafting of a BMFT main funding program called "Surface and Thin-film Technologies."

2. Microstructure Engineering Except for Microelectronics

Development of new optical components for X-ray devices, nozzles and valves, and micro composite materials with multifunctional properties produced by manufacturing techniques that are new or borrowed and modified from semiconductor engineering. New analytical instruments with extremely high structural discrimination such as scanning tunnel microscopes.

3. Plasma Technology

Developmental projects in selected and model fields (X-ray sources, material depositions in discharges) for confirmation of their technology potential. Process-engineering developments for applications in metallurgy and for materials processing in which plasmas play a substantial role, welding techniques, and studies on rapidly changing plasma systems, for example for the purpose of using them in high-speed pulse engineering and switchgear engineering.

4. Superconductor Technology

Development of superconductors, especially of new high-temperature superconductors, and their application. To this end, on the one hand support is being given to basic research in the elaboration of model representations to clarify the phenomenon and also in the working out of process techniques for reproducible production, in shaping and further-processing procedures for wires, bands, sintered semifinished products or thin-film structures, in applications-related studies, for example on magnet construction, electronics, and new application fields in general. As the first step in this area, early in 1987 a group project with about 30 participants was begun in the universities.

On the other hand, pilot projects for making applications accessible to industrial outfits are to be carried out by way of contracts: Measuring and analytical instruments; cables for power transmission; superconducting magnets, for example for NMR tomography, ore separation, isolation of heavy metals; motors; switches, energy storage devices, transformers. Periodically arranged meetings are providing a suitable exchange of information.

**Laser Technology**

To an increasing degree laser technology is making its way into important industrial fields. It has become a key technology whose potential ranges over manufacturing technology, mensuration and analysis, medicine, communications and information engineering, and many other fields.

The BMFT is energetically supporting the endeavors of German industry and the research institutions in their effort to carry out research that is of the highest standards internationally and is needed for the industrial sector. Assistance funds totaling about DM194 million are earmarked for the years 1987 to 1990.

In industrial branches such as vehicle construction (especially the automobile industry), electrical engineering, machine and ship building, and electronics, the technological potential of the laser makes possible an improved international competitiveness, for example in connection with new machining processes and new products. The advantages of the laser are leading to economical uses in all areas where precision, flexibility, and quality are decisive factors. The prerequisites for profitably using lasers in the individual case are the availability of suitable laser systems as well as a broad base of knowledge and experience, which must be created by industrial basic research and applied research.

Objects of the research projects are:

1. The working of materials using:

- $CO_2$ lasers (separating, joining, surface working, abrasive removal)
- Solid-state lasers (separating, welding, surface working, joining, abrasion and drilling, combined processes)
- Excimer lasers (foundations of the interaction of radiation/matter, abrasion, structure-changing processes).

2. New techniques of material working:

- Deposition methods
- Structurization of surfaces by L-CVD [laser chemical vapor deposition]
- Laser metal-plating.

3. Foundations of laser-based design, fabrication, and production

4. Studies on safety aspects in working of materials using lasers

5. Lasers in mensuration and analysis:

- Laser holography
- Laser mass spectrometry
- Precision measuring methods

6. Laser technology for medicine:

- Therapy
- Diagnosis

7. Foundations of laser equipment engineering:

- Sources of laser beams (optimizing output power, beam quality, lifetime)
- Components (optics, beam control, electric power supply)
- System integration (for the areas of mensuration, manufacturing technology, medicine).

The expanding world market for laser technology is governed by the competition among American, Japanese, and European firms. In the industrial and medical laser market, it has proved possible in recent years to maintain and in some cases to improve the competitiveness of German firms because of the measures taken by the BMFT.

The areas of foundations of applications-oriented processes and the research projects planned within the framework of EUREKA will be given particular weight. Both fields are characterized by the need for intensive collaborative research. The participation of German businesses and research institutions in five of seven EUROLASER projects within the scope of EUREKA has been achieved with the support of the BMFT consequent to the definition phase of these projects.

The BMFT intends to continue its hitherto successful measures, with the following objectives in the sector of laser research and laser technology as emphases of funding:

1. Expansion of the R&D infrastructure in the area of applied and industrial laser research.

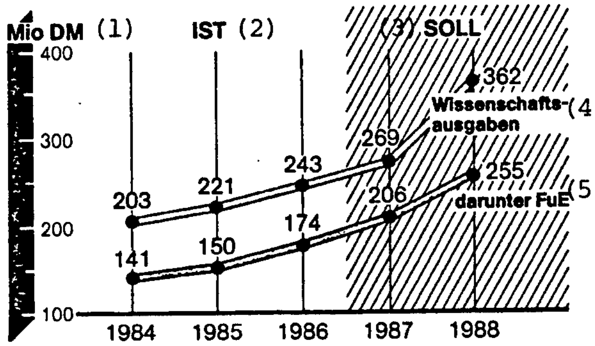
2. Supporting of initiatives and incentives for the creation of an independent and internationally competitive German laser industry, and

3. Reinforcing cooperation on a national and European level through collaborative research.

Accompanying this, the transfer of information and know-how among laser manufacturers, researchers, and users is to be supported and intensified, the aim being to introduce laser technology above all to small and medium-sized enterprises.

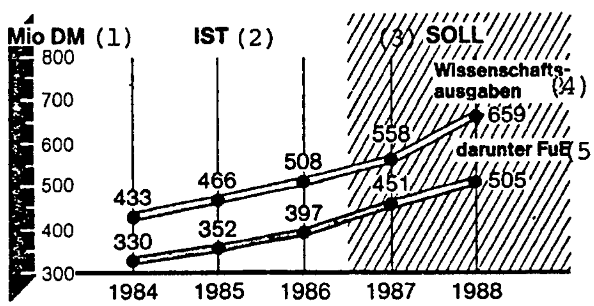
**Technology Transfer, Technology Impact Assessment, Evaluation**

The aimed-at transfer into practice of applications-oriented results of technology developments, especially into small and medium-sized businesses (focal point at present: Laser technology and surface engineering) is being expedited by means of seminars and workshops on topical problems, by informational events, and by providing working aids (manuals, guidelines). Moreover this is also being helped along by the presentation of results at fairs and congresses as well as the conducting of informational exchanges on the transfer of know-how among researchers, manufacturers, and users.




**Expenditures of the Federal Government for Physical Technologies**

Key:
1. Millions of DM
2. Actual
3. Estimated
4. Expenditures for scientific work
5. R&D portion




**Expenditures of the Federal Government for Materials Research; Chemical Process Technology; Physical Technology**

Key:
1. Millions of DM
2. Actual
3. Estimated
4. Expenditures for scientific work
5. R&D portion

Complaints that have frequently been expressed regarding impediments to the development and diffusion of laser technology are being systematically analyzed at present. These include in particular shortages of qualified personnel and questions about safety and organization of work (technology consequences assessment).

As an accompaniment to this technology funding the efficiency of such funding is also being analyzed. The goal is to examine and improve promotional objectives and measures in a timely way.

## Aircraft

*36980314 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 170-171*

[Text]

**Aeronautics Research and Development (Funding Sector M)**

The Federal Government is assisting aeronautics research and development in order

1. To consolidate the international competitiveness of our aircraft industry and to expand international cooperation

2. To ensure that we have a share in sophisticated technologies

3. To provide for an appropriate German participation in civilian aviation

4. To maintain the industrial base so that it can share in meeting the needs of the Air Force.

Aeronautics research and development gets funding from the Federal Ministry for Research and Technology [BMFT], the Federal Ministry for Transport [BMV], and the Federal Ministry for Economics [BMWi].

The funding measures of the BMFT center on

1. Improving the technological basis for future projects through research work of the DFVLR [German Research and Experimental Station for Aerospace]

2. The advance development of critical components for civilian aircraft and helicopters

3. The development and testing of technologies of aviation electronics and flight guidance/air traffic control

4. The planning and building of new large-scale test facilities.

Through contracts the federal minister for transport funds measures for improving air traffic safety, for reducing air-traffic noise, and for upgrading construction, testing, and operating regulations. Important measures in this sector are:

1. Increasing the fireproofing of aircraft cabins

2. Ways of increasing practical air safety

3. Reliability of aircraft structures

4. Elaboration of testing and approval criteria for software-dependent systems in aircraft

5. Studies on improving collision warning systems in aircraft.

Through partially repayable development-cost subsidies, the BMWi funds civilian aircraft and engine construction. This assistance is meant to support above all the participation of the German aircraft industry in technologically important and economically promising civilian projects. It is intended to strengthen the international competitiveness of the German aircraft industry and to reduce its dependence on military contracts.

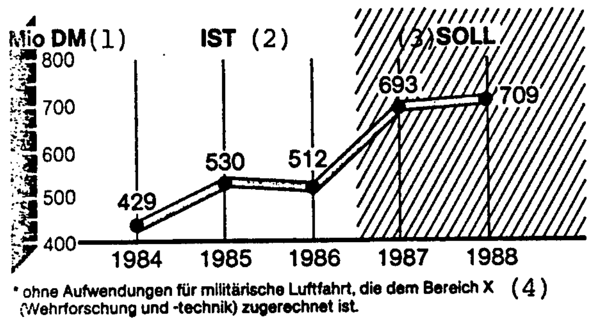
The emphasis of development assistance is on the Airbus program as the most important European cooperative project. The Airbus is the only European alternative to the U.S. manufacturers Boeing and McDonnell-Douglas in the sector of short-range and intermediate-range aircraft, and thanks to its exceptional technology it has substantially typified the standard in the sector of civilian transport aircraft.

Aeronautics research in the FRG is predominantly oriented to having an input in joint development projects with our Western partners and to making contributions to solving problems of air transport.

As important and successful cooperative efforts on the basis of a division of labor and costs we can mention the construction of the joint German-Dutch Wind Tunnel (DNW) in the Netherlands and the planned materialization of the large-scale European Transonic Wind Tunnel (ETW) project in the FRG (see Part V, Sections 3.8 and 3.9). The ETW—which is by far the most sophisticated and most expensive test facility for astronautics research and technology in Europe—will be built starting in 1988 at Cologne-Porz and will probably be available for industrial measurements from 1995 on.

Of preeminent importance for European cooperation in aeronautics research is the "Group for Aeronautical Research and Technology in Europe" (GARTEUR), established on the basis of an agreement among the governments of France, Great Britain, the Netherlands, and the FRG.

In connection with civilian development programs, European cooperation in the Airbus program can be emphasized in particular; in addition to the FRG other participants at present are France, Great Britain, Spain, and the Netherlands. In addition there are a large number of bilateral cooperative efforts.




**R&D Expenditures of the Federal Government for Aeronautics Research and Development***

Key:
1. Millions of DM
2. Actual
3. Estimated
4. *Not counting expenditures for military aviation, which is assigned to Sector X (defense research and technology)

12114

## Defense R&D Funding

*36980315Bonn BUNDESBERICHTFORSCHUNG in German Mar 88 pp 198-200*

[Excerpts]

### 2.23 Defense Research and Technology (Assistance Area X)

Defense research concerns itself—as applied research—with recognition and solution of problems as the basis for future defense products. It is the prerequisite for the planning and provision of appropriate equipment for the German Federal Armed Forces and thus contributes along with other forces to meeting the tasks of the armed forces within the alliance.

The goals of defense research are derived from the correlation between military strictures—such as the type of military threat—and S&T prognoses.

Basically, it is focused on:

—Study of new applicational possibilities for scientific phenomena for defense materiel;
—Developing new characteristics for defense materiel;
—Removal of previously unrecognized risks from defense materiel.

Defense research should assure the broadest and solidest possible technological basis for the safe and extensively low-risk planning and development of new defense materiel and the mastery of cutting edge technologies in some areas which are especially important to the German Federal Armed Forces. It should also form the basis for sound judgment in international dialog and for cooperation in the design of new technical and military concepts.

Establishing objectives, managing projects, and monitoring success are ministerial tasks because of their direct relation to the planning process within the German Federal Armed Forces. Performance of defense research projects is centered in the defense-related research institutes which are for the most part fully subsidized. In addition, individual contracts are worked on in private industry and at FRG universities.

The use of research results from the civilian sector for defense-related tasks occurs in many ways. One of these ways is through jointly contracted complementary programs with the BMFT [Federal Ministry for Research and Technology] (e.g., in microelectronics); another way is through organizational or general scientific contacts, e.g., through membership in committees of experts or working in research facilities that contain civilian and military components, such as the Fraunhofer Society and the German Research and Test Facility for Aeronautics and Space [DFVLR].

It is further assured on the national level by cooperation of research institutes with relevant industry and, where necessary, through appropriate management from the government.

Economic conditions and the gradual definition of need as well as technical advances make a periodic updating of mid- and long-term goals of defense research and technology (R&T) absolutely necessary.

The BMVg [Federal Ministry of Defense] has taken this necessity into account by designing a comprehensive R&T plan and by annually formulating an R&T guideline based on the R&T plan.

This R&T plan forms the basis for the adoption of R&T programs with the partners in the alliance as well as with the BMFT. It also serves to promote industrial initiatives in defense R&T. The R&T guideline states the goals and classifies the R&T emphases; it also gives ideas for achieving these goals. Finally, it also points out technological gaps which must be addressed nationally as a result of defining emphases and financial limitations after agreement with the NATO partners.

The R&T plan was created in close cooperation with the armed forces and the equipment division. Planning, management, and monitoring of defense R&T are subject to this plan.

Military medical research is imperative for meeting the responsibilities of the medical and health service of the German Federal Armed Forces, which include preventive and clinical health care, the military pharmacy, and the military veterinary service.

This is applied research with the objective, for members of the German Federal Armed Forces:

—of improving adaptation to the peculiarities of military service;
—of achieving an increase in efficiency;
—of raising resistance against certain environmental influences;
—of facilitating better integration of the human being into the highly technical environment by establishing performance and stress profiles; and
—of being able to recognize and better treat health problems caused by the military environment or weapons.

However, because there are strict limitations to the adaptability of the human being to the environment, this military medical research must grapple intensively with health-threatening effects of the military environment and continue to work on the greatest possible reduction of this threat.

The clearly defined goal of military medical research is the protection, maintenance, and restoration of the health of the members of the armed forces under all conceivable conditions.

This exclusively humanitarian goal of military medical research delimits all projects which serve for testing or optimization of weapons systems.

In addition to the military medical questions rising from the peacetime role of the medical service, there is specific attention to specialized scientific preparation for the care of ill, injured, and wounded soldiers in a war.

To that end, possible threats must be analyzed and ways and means found to meet them effectively.

Although the area of conventional weapons must not be neglected here, it is also necessary to devote special attention to the effects of ABC weapons. Particularly in the area of medical AC protection as well as in B protection, new means and medical procedures must be continually researched and developed to reduce the effects of weapons, to be able to give the best possible aid to those injured by such weapons, or even, based on medical knowledge and research results, to work to prevent the introduction, dissemination, or use of certain weapons.

The spectrum of military medical research includes the entire range of medicine and its peripheral areas.

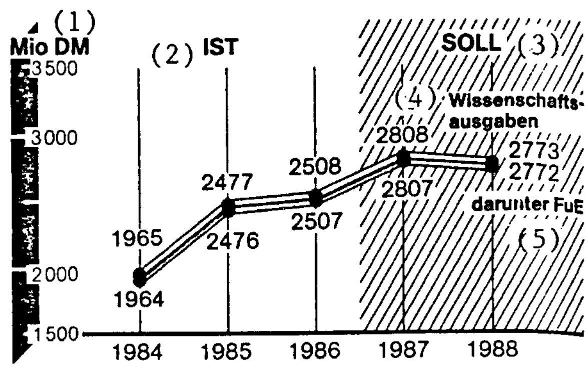
The objective of defense development and testing is, based on the results of defense research, modernization of the equipment of the German Federal Armed Forces on the basis of the German Federal Armed Forces plan and requirements derived from it through the provision of materiel which is ready for use—with extensive cooperation from the NATO partners.

On the front line of the development of projects and devices, technological and feasibility studies and component and experimental development all contribute to limiting the technical, temporal, and economic risks of future developmental projects.

The "Device and Project" area includes the development and testing of specific, defined defense materiel from the idea to the technically mature product ready both for use by the troops and for series production.

For reasons of standardization/interoperability and to avoid duplication of effort, cooperation within NATO is constant (see also Part V, Section 2.4). Few development projects are carried out exclusively on the national level.

Active interchange of information also occurs in research.




**Federal Expenditures for Defense Research and Technology**

Key:
1. Millions of DM
2. Actual
3. Estimated
4. Scientific expenditures
5. Including R&D

12666

## Science-Industry Transfer of Knowledge, Personnel

*36980316 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 186-189*

[Excerpts]

### Improvement of Technology and Knowledge Transfer

### Technology Transfer and Consultation

The BMFT [Federal Ministry for Research and Technology] model projects for innovation and technology consultation were concentrated primarily on small and medium size companies in order to provide them with assistance in opening up markets for R&D results where needed. The sharp increase in these types of consultative

offices in recent years is to be regarded as a significant success of the model projects, and has thus permitted a gradual termination of assistance. In 1987, another such project (tribology consultation) was being supported.

Besides consultation for small businesses, consultative offices for employers (representatives) and developing countries are being supported.

**Contract Research and Development for Companies in Trade and Industry**

In February 1984, the project for assisting companies that award research and development contracts to outside third parties, which had been in existence since 1978, was expanded significantly. The amount of approved funding increased from DM14 million in 1983 to DM52 million in 1986.

In the meantime, funding has been applied for by more than 4,000 companies, some more than once. Thus, it has reached a not inconsiderable part of the potential target group for research and development. The percentage of contract research within overall R&D expenditures in trade and industry has doubled over the last 10 years. The program has contributed to this trend, since the proportionate subsidization of 30/40 percent has triggered a contract research volume of more than DM800 million.

A change in the assistance program beginning in 1988 takes this into account and concentrates aid on companies that have not yet been reached and on intensifying the transfer of technology between research institutions and small and medium size companies during the awarding of outside contracts (in contrast to the transfer of personnel, which is promoted by the following measure).

**Research Cooperation Between Industry and Research Institutions Through Young Scientists**

This assistance program is designed to improve the transfer of new scientific knowledge into the economy in the area of key technologies. At the same time, young scientists who are sent to research institutions gain special qualifying opportunities in future technologies.

The program is set up so that the companies are reimbursed for part of the personnel costs if they send young employees with college degrees to certain research institutions for a period of time.

The program is used by both small and large companies. Around 50 percent of the funding goes to companies with less than 500 employees. A good one-third of the cooperative arrangements are in the area of information-technology, while one-fifth are in manufacturing technology. Other focal points are biotechnology, materials-research and environmental and recycling technologies. A good three-quarters of the partners are universities, technical colleges and trade colleges. Just under one-third pertain to cooperative ties with institutes of the Max Planck Society, the major research facilities, the Fraunhofer Society, and Industrial Joint Research institutes.

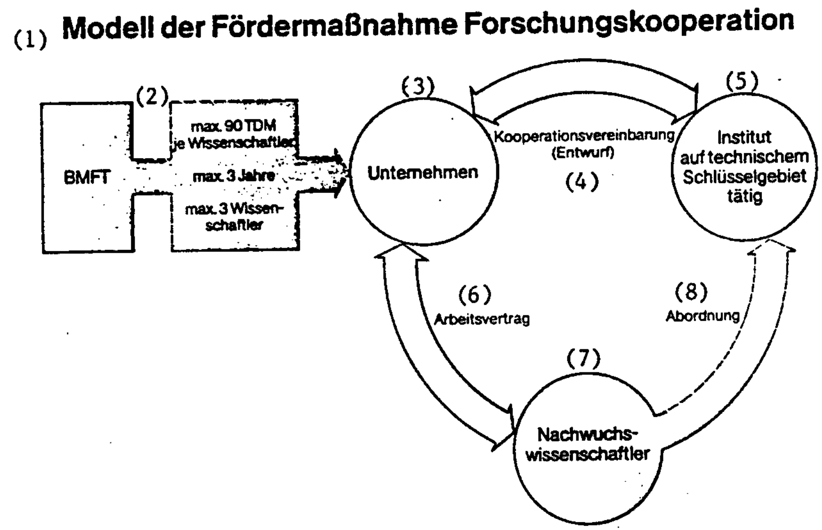
Thus far, 660 grants for cooperative research arrangements have been awarded. In the concomitant scientific research being undertaken by Battelle, Frankfurt, it is emphasized that a high initial effect results from the research cooperation. Only in 11 percent of the cases was there a similar form of cooperation between research institutions and companies prior to introduction of the assistance program. Battelle also noted that a great deal of "head-to-head technology transfer" takes place during and after the cooperative research project, through exchanges of information and an ongoing rise in the qualifications of young scientists.

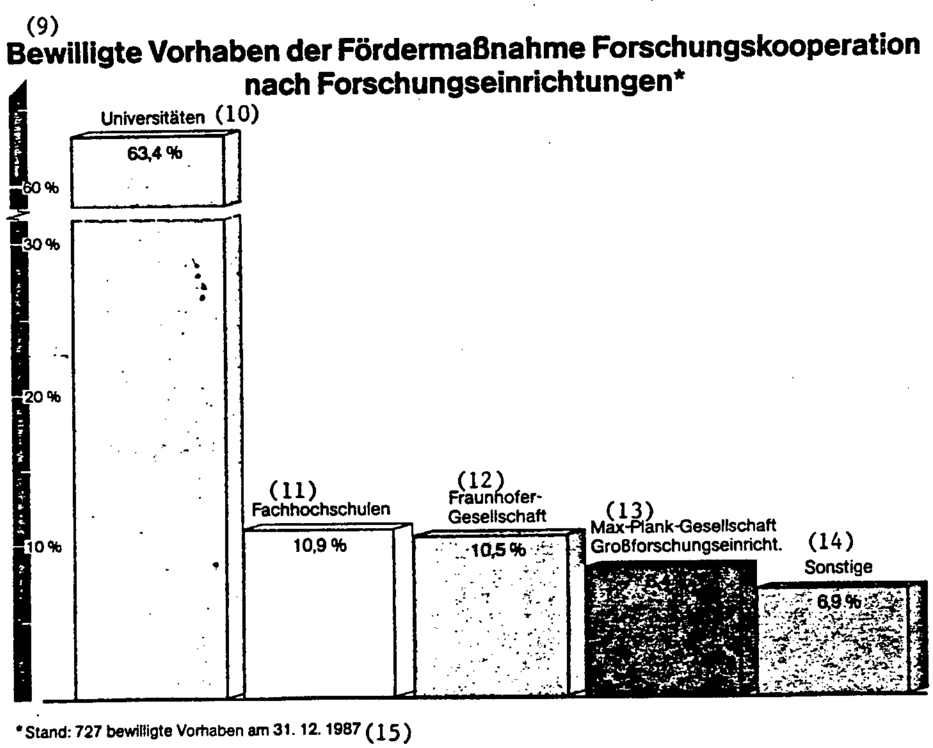
**Supporting Technology-Oriented Company Start-Ups**

The federal government began this model program in the summer of 1983, in order to provide special assistance for technology-oriented company start-ups (TOU) and young businesses. The goal of the program is to determine the best possible assistance instruments for promoting these types of companies, in order to stimulate risk capital for commitment to such firms.

Up to 30 June 1987, funding amounting to DM182 million had been provided to 336 existing and future companies during the various phases of the model program.

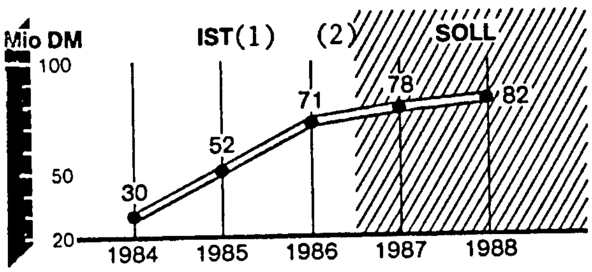
The model program, which was originally due to expire by 1986, has in the meantime been extended until 1988. Various measures for evaluating the results have been introduced.



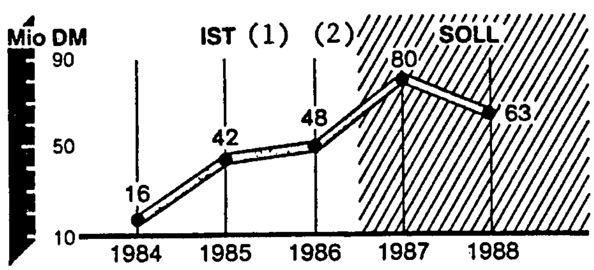

**Delegating Industrial Personnel to Publicly Financed Research Institutions**

Key:—1.Model for the Research Cooperation Assistance Program—2.BMFT; Max. DM90,000 per scientist; Max. 3 years; Max. 3 scientists—3.Company—4.Cooperative agreement (draft)—5.Institute active in area of key technology—6.Employment contract—7.Young scientist—8.Delegation—9.Approved Projects in the Research Cooperation Assistance Program to Research Institutions*—10.Universities—11.Technical and trade colleges—12.Fraunhofer Society—13.Max Planck Society, major research facilities—14.Other—15.*Status: 727 approved projects on 31 December 1987



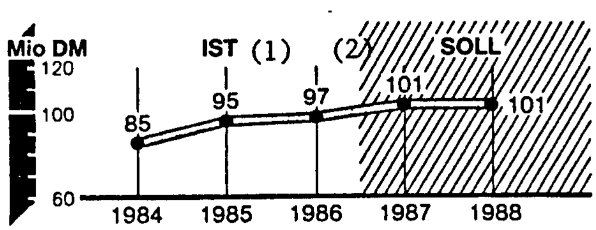

**R&D Expenditures by the Federal Government for Promoting Technology-Oriented Company Start-Ups**

Key:
1.Actual
2.Estimated




**R&D Expenditures by the Federal Government for Improving the Transfer of Technology and Knowledge**

Key:
1.Actual
2.Estimated




**R&D Expenditures by the Federal Government for Other Indirect Assistance Programs (Without Indirect-Specific)**

Key:
1.Actual
2.Estimated

12271

## R&D Spending by Selected Organizations

### Introduction

*36980317 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 p 277*

[FRG Federal Government report, 11th term]

[Text]

**Support Organizations and Research Institutions in the FRG**

This overview of those organizations and research institutions which are partly financed with federal funds or in which the Federal Government collaborates, to a large extent reflects the multilayered system of research support in the FRG. This diversity provides for wholly different forms and ways of support, appropriate to the variety of the forms of research. Because of their great flexibility in supporting new themes, the foundations are given special importance.

A glance at the principal groups of institutions described in the following illustrates this diversity:

—Diverse forms of autonomy, decentralization and subsidies are evident for the largest support organizations (more under 2) and the two principal sponsor organizations for research in the FRG (MPG [Max Planck Society and FhG [Fraunhofer Society], described under 3). At the university level, the DFG [German Research Organization] occupies a supreme position.

—The continuous and trustful cooperation between the Federal government and the states in supporting research, made possible through Article 91 b of the Constitution, shows up particularly in basic long-range financing of many of the organizations and research institutions described in Part IV. Among the group included in the framework agreement concluded on this basis in 1975 between the Federal government and the states regarding joint support for research, belong in particular the following institutions:

- The already mentioned support or sponsor organizations DFG, MPG or FhG.
- The major research installations supported at a 90:10 ration by the Federal Government and the states (see under 4).
- The institutions on the so-called "blue list" described under 5, which are financed largely at a 50:50 ratio.

—The federal institutions described under 6 show the significance of research for the fulfillment of the tasks of individual federal departments.

—The information and documentation institutions listed under 7 explain the increasing function of this infrastructure for science.

—The project executors listed under 8 refer to the decentralized management of project support tasks, which thus take place as closely as possible to the relevant scientific institutions.

## Max Planck Society

*36980317 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 285-86*

[Text]

### 3.1 Max-Planck-Gesellschaft zur Foerderung der Wissenschaften e.V. (MPG), Residenzstrasse 1a, 8000 Munich 1

Institutional support: Federal Government (50 percent) and states (50 percent).

### Tasks

The Max Planck Society for the Advancement of the Sciences, reg. assn.

- is a support organization for at present about 60 non-teaching institutes, research centers and time-limited clinical research and working groups of varying size, structure and set of tasks;
- conducts basic research in selected areas of the humanities, the natural and social sciences;
- promotes new fields of research, thus supplementing research at the university level;
- cooperates with the university-level institutions as well as makes its large equipment available for university-level research.

### Structure and Budget

As an independently managed scientific organization, the Max Planck Society allows its leading scientists a free hand in choosing research subjects and carrying out their research projects.

In addition to funding from institutions, the Max Planck Society also receives project development funds, as well as private funds, in order to finance its research institutions.

**MPG Budget in Million DM**

| | Actual figures | | Estimate for |
|---|---|---|---|
| Expenditures in million DM from general budget[1]) | 1985 | 1986 | 1987 |
| Fixed expenses of which: | 717.4 | 743.8 | 771.2 |
| Personnel costs | (432.2) | (450.4) | (471.7) |
| Investments of which: | 120.9 | 121.6 | 130.6 |
| Constructions | (50.1) | (53.3) | (52.8) |
| Total | 838.3 | 865.4 | 901.8 |
| For information: | | | |
| Project development 1987 | | | 81.9 |
| Sum total | | | 983.7 |

| Personnel | 1985 | 1986 | Actual figures as of 6-30-87 |
|---|---|---|---|
| Researchers | 1,798 | 1,804 | 1,767 |
| Technicians | 2,643 | 2646 | 2,611 |
| Others | 2,464 | 2,497 | 2,510 |
| Total | 6,905 | 6,947 | 6,888 |

[1]) Total MPG budget without expenses for the Max Planck Institute for Plasma Physics, including grants for the independent MPI for Iron Research and MPI for Coal Research.
Source: BMFT [Federal Ministry for Research and Technology]

**Support for Research Fields by the Max Planck Society Based on the 1987 Budget Plan Including Project Development**

| Research field | Expenses 1,000 DM | Scientific personnel | Percentage Expenses | Percentage Scientific personnel |
|---|---|---|---|---|
| Chemistry | 114,139 | 225 | 11.6 | 12.3 |
| Physics | 247,073 | 411 | 25.1 | 22.5 |
| Astronomy, astrophysics | 116,832 | 227 | 11.9 | 12.4 |
| Atmospheric sciences, geosciences | 49,098 | 93 | 5.0 | 5.1 |
| Mathematics | 4,370 | 4 | 0.4 | 0.2 |
| Information science | 4,934 | 3 | 0.5 | 0.2 |
| Biologically oriented research | 249,822 | 463 | 25.4 | 25.4 |
| Medically oriented research | 122,839 | 169 | 12.5 | 9.3 |
| Jurisprudence | 35,108 | 117 | 3.6 | 6.4 |
| Historical sciences | 10,116 | 30 | 1.0 | 1.6 |
| Social sciences | 29,354 | 84 | 3.0 | 4.6 |
| | 983,685 (1) | 1,826 | 100.0 | 100.0 |

1) Including centrally funded expenses and expenditures for investments
Source: Federal Ministry for Research and Technology

## Fraunhofer Society

*36980317 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 289-290*

[Excerpt]

**3.2 Fraunhofer Society for the Advancement of Applied Research e.V (FhG), Leonrodstrasse 54, 8000 Munich 19**

*Financing:*

a) Contract research institutions: about 65 percent FhG's own income and about 35 percent result-dependent institutional support—of which 90 percent from the Federal Government/BMFT and 10 percent from seven states;

b) two service establishments: 25 percent FhG's own income and 75 percent institutional support—of which 90 percent from the BMFT and 10 percent from seven states;

c) six defense-related research facilities: 100 percent support by the Federal Government/BMVg [Federal Ministry for Defense] (institutional support and project financing).

**Tasks**

*—Contract research*

Research contracted by business, industry and public authorities:

- the FhG has special R&D support opportunities for medium size enterprises.

Project research within the framework of state support programs:

- in particular research interconnected with business enterprises and other R&D.

FhG's own research projects with funds from institutional support serve to maintain scientific standards and to open up new research fields in the forefront of contract and project research.

*Defense Research*

Departmental research for the Ministry of Defense

*Services*

Patent office for German research as a service establishment for public research facilities and independent inventors;

RAUM and BAU information centers, as a data bank supplier for the fields of regional planning, urban construction, the housing and construction sectors.

### Structure and Budget

The FhG's business is conducted by the board of directors; it is supported in this task by the central administration. The senate determines the basic outlines of research policy, research and expansion plans and decides about the establishment or closing of institutes. It is elected by the general meeting of members. The institutes carry out the FhG's research work. The directors of the institutes, and, as needed, of the organs of the society as well, are assisted and advised by the boards of curators of the institutes. In scientific and technical matters of fundamental importance, the science and technology council advises the other organs of the society.

**Research Fields of the Fraunhofer Society**

| Research field | Employees 1987 | 1987 Expenditures (in million DM) |
|---|---|---|
| Microelectronics | 475 | 63 |
| Information technology | 328 | 44 |
| Production automation | 441 | 59 |
| Production technologies | 235 | 31 |
| Behavior of materials and components | 542 | 72 |
| Process engineering | 350 | 47 |
| Energy and construction technology | 266 | 35 |
| Environmental research | 386 | 51 |
| Technical and economic studies/technical information | 197 | 26 |
| Total | 3,220 | 428 |

| Revenue from R&D in million DM (1) | Actual figures (2) | | Estimate for 1987(3) |
|---|---|---|---|
| | 1985 | 1986 | |
| | 226 | 278 | 240 |

| Expenditures in million DM | Actual figures (2) | | Estimate for 1987(3) |
|---|---|---|---|
| | 1985 | 1986 | |
| Fixed expenses | 292 | 340 | 337 |
| of which: | | | |
| Personnel costs | (195) | (222) | (235) |
| Investments | 146 | 171 | 153 |
| of which: | | | |
| Construction | (77) | (94) | (62) |
| Total | 438 | 511 | 490 |

| Personnel (4) | 1985 | 1986 | Actual figures as of 6-30-87 |
|---|---|---|---|
| Researchers | 988 | 1,052 | 1,109 |
| Technicians | 584 | 617 | 653 |
| Others | 963 | 1,011 | 1,078 |
| Total | 2,535 | 2,680 | 2,840 |

(1)FhG contract research income from the Federal Government, states, industry, economic associations, institutions for the promotion of research, other
(2)The actual figures were considerably higher than the corresponding estimate of the economic plan
(3)Estimate according to the economic plan
(4)Without project-related temporary positions (according to the Federal Budget
Source: BMFT

## Selected Large Research Institutes

*36980317 Bonn BUNDESBERICHT FORSCHUNG 1988 in German Mar 88 pp 293-308*

[Excerpts]

### 4. Large Research Institutes

### 4.1 Tasks and Structure of the Large Research Institutes

(Budget and personnel data are taken from the Federal Budget Plan and include institutional support; project funds and project positions were not taken into account.)

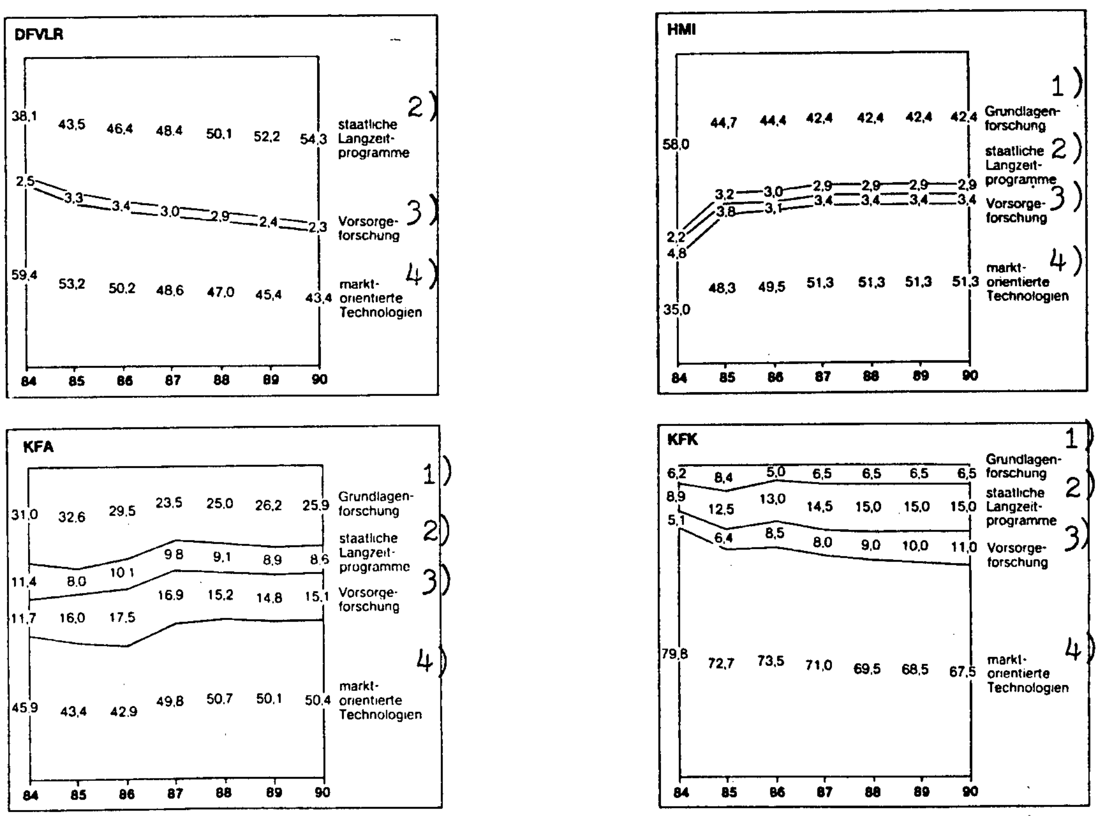
The 13 major research institutes (GFE) are a significant component of the research and development capacity of the FRG. At present they have nearly 20,000 employees (including project positions, trainees, visiting researchers, etc.) and are supported at a ratio of 90 percent by the Federal Government and 10 percent by one or more situs states. Legally, most of them are organized as limited corporations, some as foundations (AWI [Alfred Wegener Institute for Polar Research], DESY [German Electron Synchrotron], DKFZ [German Cancer Research Center]) and DFVLR [German Aerospace Research and Testing Institute] as a registered association. Business management is headed by the boards of

directors, on which as a rule both scientific and commercially trained managers are represented. The funding body, the Federal Government, exercises its guiding influence on the supervisory committees, among others, where, in addition to representatives of the Federal Government and the states external representatives from the scientific and economic fields, as well as scientific staff members from the institutes participate. Yet another essential instrument of control is the annual economic plan discussions of the allocating bodies with the boards of directors or business managements of the major research institutes.

The establishment of the major research institutes, mainly in the fifties and sixties, took place principally for the purpose of establishing and expanding nuclear research and technology, aerospace research, data processing and later biological and medical research. Today, the major research institutes contribute to the achievement of the Federal Government's goals in research and technology policy in the fields of long-range state programs (ocean research, polar research, space research, fusion research), in preventive health care research (environmental, climate, health and safety research, as well as evaluation of the results of technology) and in basic natural scientific research, above all with major equipment, and in the development of market-oriented technologies (such as materials research, biotechnology research, energy research and technology, as well as underwater technology).

This is, as was shown in Part I, partly the result of a reorientation introduced by the Federal Government for a series of institutes, forming an opening for new scientific subject studies (see profile descriptions below).

An important requirement imposed by the Federal Government in the most recent Federal Research Report was increased orientation by the major research institutes toward usefulness in the economy, in particular in business and industry. A clear increase in licensing and know-how contracts by nearly all institutes is proof of a positive development in the cooperation with business and industry, as is a growing number of interconnected research projects (projects carried out jointly by industrial enterprises and research institutes). In order further to reinforce the bond with the economy, the Federal Government has begun to send persons from the economy to sit as chairmen on the supervisory committees of the GMD [Society for Mathematics and Data Processing] and GBF [Society for Biotechnological Research], that is to say institutes particularly geared toward application.




Key:—1.Basic research—2.Long-range state programs—3.Preventive health care research—4.Market-oriented technologies

**Total Outlays of the GFE for Research and Development 1987 Tabulated by Research Fields and Facilities (1)** (in million DM)

| | AWI | DESY | DFVLR | DKFZ | GBF | GKSS | GMD | GSF | GSI | HMI | IPP | KFA | KfK | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fast breeders | | | | | | | | | | | | | 81.6 | 81.6 |
| High-temperature reactors | | | | | | | | | | | | 54.0 | | 54.0 |
| Uranium enrichment | | | | | | | | | | | | | 10.4 | 10.4 |
| Reprocessing, permanent storage | | | | | | | | 18.4 | | 5.9 | | 7.3 | 85.0 | 116.6 |
| Safety of nuclear engineering installations | | | | | | 16.1 | | | | | | 9.6 | 12.7 | 38.4 |
| Nuclear fusion, plasma physics and technology | | | | | | | | | | | 134.0 | 47.3 | | 181.3 |
| Fusion technology | | | | | | | | | | 1.6 | | 5.2 | 64.5 | 71.3 |
| Non-nuclear energy systems | | | 31.0 | | | | | | | 6.5 | | 9.0 | | 46.5 |
| **Energy Research and Energy Technology** | | | **31.0** | | | **16.1** | | **18.4** | | **14.0** | **134.0** | **132.4** | **254.2** | **600.1** |
| Land-based transportation systems | | | 6.3 | | | | | | | | | | | 6.3 |
| Aviation technology | | | 164.8 | | | | | | | | | | | 164.8 |
| **Transportation systems** | | | **171.1** | | | | | | | | | | | **171.1** |
| Space research | | | 54.7 | | | | | | | | | | | 54.7 |
| Aerospace technology | | | 100.4 | | | | | | | | | | | 100.4 |
| **Space research, aerospace technology** | | | **155.1** | | | | | | | | | | | **155.1** |
| Technologies for using the oceans | | | 2.2 | | | 25.0 | | | | | | | | 27.2 |
| Polar research | 25.0 | | | | | | | | | | | | | 25.0 |
| **Ocean research & technology, polar research** | **25.0** | | **2.2** | | | **25.0** | | | | | | | | **52.2** |
| Cancer research | | | | 88.2 | | | | 13.5 | | | | | | 101.7 |
| Medical research and procedures | | | 2.7 | | | | | 38.3 | | 3.6 | | 12.5 | | 57.1 |
| Environmental effects on biological systems | | | | | | | | 29.5 | 3.4 | | | 5.2 | 7.9 | 46.0 |
| Biotechnology | | | | | 44.7 | | | | | | | 12.1 | | 56.8 |
| Environmental exploration and climate research | | | 10.0 | | | 22.5 | | 21.5 | | | | 25.7 | 10.3 | 90.0 |
| Environmental protection technology | | | 18.3 | | | 5.5 | | 0.8 | | | | 14.0 | 17.2 | 55.8 |
| **Health, environment, biotechnology** | | | **31.0** | **88.2** | **44.7** | **28.0** | | **103.6** | **3.4** | **3.6** | | **69.5** | **35.4** | **407.4** |
| Elements of information technology | | | 12.6 | | | | 14.3 | | | | | 1.2 | | 28.1 |
| Technologies for information technology | | | | | | | 10.6 | | | | | 27.2 | 7.3 | 45.1 |
| Systems technology | | | 9.4 | | | | 48.3 | | | 2.4 | | 1.2 | | 61.3 |
| Applications of information technology | | | 0.9 | | | | 44.5 | | 3.8 | 1.2 | | 4.9 | | 55.3 |
| Manipulation technology, robotics | | | 2.6 | | | | | | | | | | 12.8 | 15.4 |
| **Information and communications technology, production technology** | | | **22.5** | | | | **117.7** | | **3.8** | **3.6** | | **34.5** | **20.1** | **205.2** |
| Low-temperature and superconductor technologies | | 18.0 | | | | | | | | | | | | 18.0 |
| Methods to assure the supply of raw materials | | | | | | | | | | 3.6 | | 8.1 | | 11.7 |
| Materials and surface research | | | 4.7 | | | 19.0 | | | | | | 34.8 | 12.5 | 71.0 |
| Measurement and process technology | | | | | | | | | | | | 32.6 | 10.6 | 43.2 |
| **Basic technologies** | | **18.0** | **4.7** | | | **19.0** | | | | **3.6** | | **75.5** | **23.1** | **143.9** |
| Nuclear chemistry, radiation and photoelectric chemistry | | | | | | | | | | 7.2 | | 5.6 | 1.5 | 14.3 |
| Elementary particle physics, meson research | | 303.0 | | | | | | | | | | | 13.2 | 316.2 |
| Nuclear physics and heavy ion research | | | | | | | | | 125.1 | 29.3 | | 30.1 | 7.2 | 191.7 |
| Solid state research | | 19.0 | | | | | | | 3.4 | 26.5 | | 58.0 | 22.0 | 128.9 |
| **Research into the foundations of matter** | | **322.0** | | | | | | | **128.5** | **63.0** | | **93.7** | **43.9** | **651.1** |
| **Total expenditures by the AGF [Working Group of Large Research Institutions** | 25.0 | 340.0 | 420.6 | 88.2 | 44.7 | 88.1 | 117.7 | 122.0 | 135.7 | 87.8 | 134.0 | 405.6 | 376.7 | 2386.1 |

1) The figures given in the table are only expenditures for research and development. The total outlay must be supplemented with the infrastructure costs which cannot be taken into account under R & D. Source: AGF

**Labor Input by the GFE for R & D in 1987 Tabulated by Research Fields and Facilities (in man years)**

| | AWI | DESY | DFVLR | DKFZ | GBF | GKSS | GMD | GSF | GSI | HMI | IPP | KFA | KfK | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fast breeders | | | | | | | | | | | | | 200 | 200 |
| High-temperature reactors | | | | | | | | | | | | 60 | | 60 |
| Uranium enrichment | | | | | | | | | | | | | 40 | 40 |
| Reprocessing, permanent storage | | | | | | | | 78 | | 29 | | 25 | 256 | 388 |
| Safety of nuclear engineering installations | | | | | | 30 | | | | | | 35 | 46 | 111 |
| Nuclear fusion, plasma physics and technology | | | | | | | | | | | 471 | 130 | | 601 |
| Funsion technology | | | | | | | | | | 8 | | 14 | 206 | 228 |
| Non-nuclear energy systems | | | 135 | | | | | | | 40 | | 42 | | 217 |
| **Energy Research and Energy Technology** | | | **135** | | | **30** | | **78** | | **77** | **471** | **306** | **748** | **1845** |
| Land-based transportation systems | | | 35 | | | | | | | | | | | 35 |
| Aviation technology | | | 836 | | | | | | | | | | | 836 |
| **Transportation systems** | | | **871** | | | | | | | | | | | **871** |
| Space research | | | 264 | | | | | | | | | | | 264 |
| Aerospace technology | | | 430 | | | | | | | | | | | 430 |
| **Space research, aerospace technology** | | | **694** | | | | | | | | | | | **694** |
| Technologies for using the oceans | | | 18 | | | 101 | | | | | | | | 119 |
| Polar research | 169 | | | | | | | | | | | | | 169 |
| **Ocean research & technology, polar research** | **169** | | **18** | | | **101** | | | | | | | | **288** |
| Cancer research | | | | 445 | | | | 66 | | | | | | 511 |
| Medical research and procedures | | | 22 | | | | | 199 | | 13 | | 46 | | 280 |
| Environmental effects on biological systems | | | | | | | | 150 | 3 | | | 16 | 36 | 205 |
| Biotechnology | | | | | 202 | | | | | | | 62 | | 264 |
| Environmental exploration and climate research | | | 49 | | | 106 | | 119 | | | | 110 | 46 | 430 |
| Environmental protection technology | | | 97 | | | 31 | | 3 | | | | 63 | 57 | 251 |
| **Health, environment, biotechnology** | | | **168** | **445** | **202** | **137** | | **537** | **3** | **13** | | **297** | **139** | **1941** |
| Elements of information technology | | | 59 | | | | 81 | | | | | 7 | | 147 |
| Technologies for information technology | | | | | | | 32 | | | | | 129 | 27 | 188 |
| Systems technology | | | 41 | | | | 287 | | | 20 | | 7 | | 355 |
| Applications of information technology | | | 7 | | | | 211 | | 6 | 7 | | 27 | | 258 |
| Manipulation technology, robotics | | | 17 | | | | | | | | | | 51 | 68 |
| **Information and communications technology, production technology** | | | **124** | | | | **611** | | **6** | **27** | | **170** | **78** | **1016** |
| Low-temperature and superconductor technologies | | 35 | | | | | | | | | | | | 35 |
| Methods to assure the supply of raw materials | | | | | | | | | | 13 | | 34 | | 47 |
| Materials and surface research | | | 31 | | | 73 | | | | | | 142 | 36 | 282 |
| Measurement and process technology | | | | | | | | | | | | 97 | 44 | 141 |
| **Basic technologies** | | **35** | **31** | | | **73** | | | | **13** | | **273** | **80** | **505** |
| Nuclear chemistry, radiation and photoelectric chemistry | | | | | | | | | | 33 | | 21 | 4 | 58 |
| Elementary particle physics, meson research | | 751 | | | | | | | | | | | 24 | 775 |
| Nuclear physics and heavy ion research | | | | | | | | | 219 | 56 | | 121 | 21 | 417 |
| Solid state research | | 53 | | | | | | | 4 | 88 | | 167 | 65 | 377 |
| **Research into the foundations of matter** | | **804** | | | | | | | **223** | **177** | | **309** | **114** | **1627** |
| **Total (without infrastructure personnel)** | 169 | 839 | 2041 | 445 | 202 | 341 | 611 | 615 | 232 | 307 | 471 | 1355 | 1159 | 8787 |

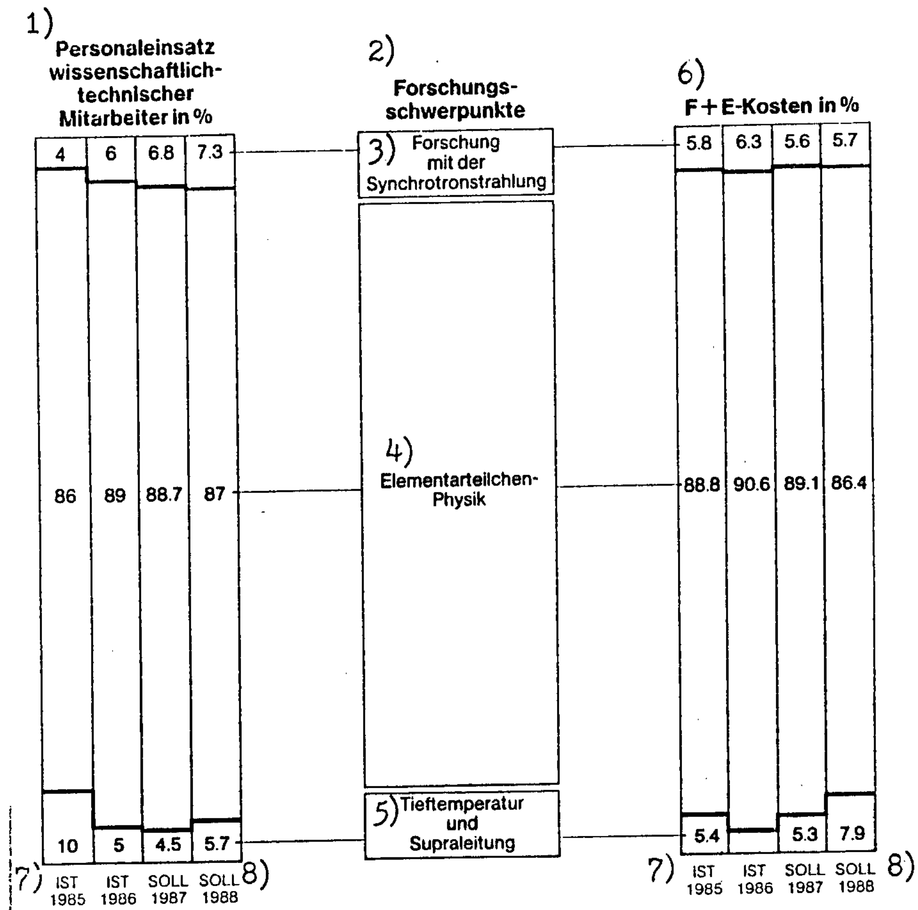
Source: AGF

**DESY [German Electron Synchrotron Foundation], Notkestrasse 85, 2000 Hamburg 52 Telephone: (040) 8998-0; Telex 2 15 124 (desy d)**

Basic research in the field of elementary particle physics (high energy physics). The experimental conditions are created by storage rings (DORIS, PETRA and later HERA). Synchrotron radiation is also made available for research into condensed matter.

After 1989, HERA will offer unique opportunities to study the structure of the proton.

| Funding | Outlay in million DM | | | Total personnel | | |
|---|---|---|---|---|---|---|
| | Actual 1985 | Actual 1986 | Est.1987 | Actual 1985 | Actual 1986 | Actual 6-30-87 |
| Federal government (90%) | 274.6 | 374.0 | 401.7 | 1,017 | 1,004 | 1,070 |
| Hamburg (10%) | | | | | | |




Key:—1.Personnel input of scientific and technical employees in percent—2.Areas of research concentration—3.Research with synchrotron radiation—4.Elementary particle physics—5.Low-temperature and superconductivity—6.R&D costs in percent—7.Actual figure—8.Estimated figure

**4.2.3 DFVLR [German Aerospace Research and Testing Institute e.V.]**

Linder Hoehe, 5000 Cologne 90

Telephone: (0 22 03) 60 11; Telex 8 874 410 (dfv d)

Research in the areas of aviation, space flight and energy (but also additional fields such as communications technology, non-nuclear energy systems, new technologies), planning and undertaking of projects, technology transfer as well as the establishment and operation of major experimental facilities.

| | Outlay in million DM | | | Total personnel[2)] | | |
|---|---|---|---|---|---|---|
| Funding | Actual 1985 | Actual 1986 | Est.1987 | Actual 1985 | Actual 1986 | Actual 6-30-87 |
| Federal government (90%) (BMFT, BMVg) | 389.6 | 427.3 | 427.8 | 2,750 | 2,752 | 2,766 |

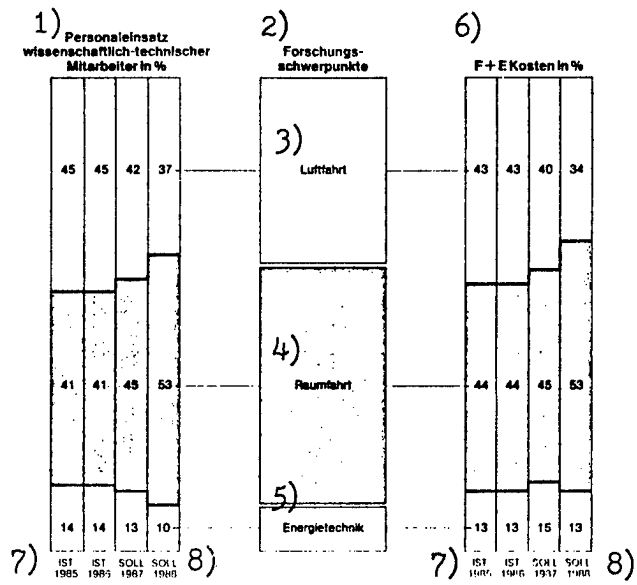
except: BMVg departmental research share of DM24 million for purposes of military aviation research

States (10%)

(Baden-Wuerttemberg, Bavaria, Lower Saxony, North Rhine Westphalia)

plus own income

[2)]Basic funding for positions under the federal employee tariff and industry-wide agreement for federal workers



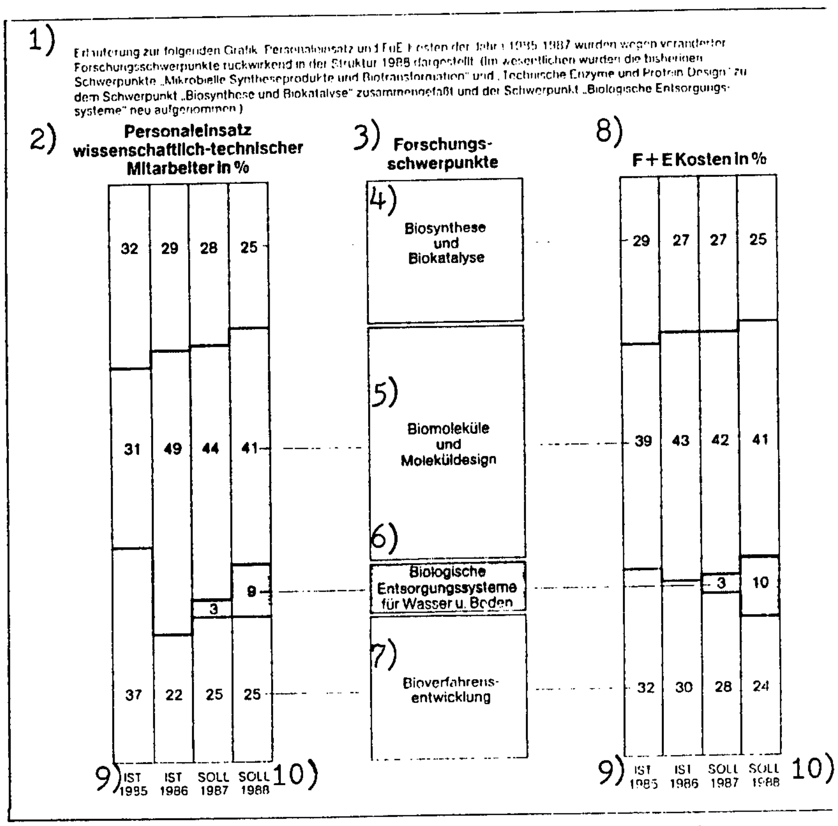

Key:—1.Personnel input of scientific and technical employees in percent—2.Areas of research concentration—3.Aviation—4.Space flight—5.Energy technology—6.R&D costs in percent—7.Actual figure—8.Estimated figure

### 4.2.5 GBF [Society for Biotechnological Research mbH]

Mascheroder Weg 1, 3300 Braunschweig
Telephone: (05 31) 70 08-1; Telex: 9 52 667 (gebio d)

Development of biotechnological products and methods and corresponding basic research with micro-organisms, animal cell cultures and enzyme systems in interdisciplinary cooperation with biology, chemistry and process technology; development of new technologies for the pharmaceutical, chemical and food industry, as well as for environmental technology.

| Funding | Outlay in million DM Actual 1985 | Actual 1986 | Est. 1987 | Total personnel Actual 1985 | Actual 1986 | Actual 6-30-87 |
|---|---|---|---|---|---|---|
| Federal Government (90%) | 35.4 | 43.9 | 62.6 | 242 | 242 | 271 |
| Lower Saxony (10%) | | | | | | |




Key:—1.Explanation for the following graph: Due to changes in research concentration, personnel input and R&D costs for the years 1985-87 are shown retroactively in the 1988 structure. (Essentially, the former concentrations of "Microbial Synthetic Products and Biotransformation" and "Technical Enzymes and Protein Design" were combined into the concentration "Biosynthesis and Biocatalysis," and the concentration "Biological Disposal Systems" was included for the first time.)—2.Personnel input of scientific and technical employees in percent—3.Areas of concentration—4.Biosynthesis and biocatalysis—5.Biomolecules and molecular design—6.Biological disposal systems for water and soil—7.Development of biomethodology—8.R&D costs in percent—9.Actual figure—10.Estimated figure

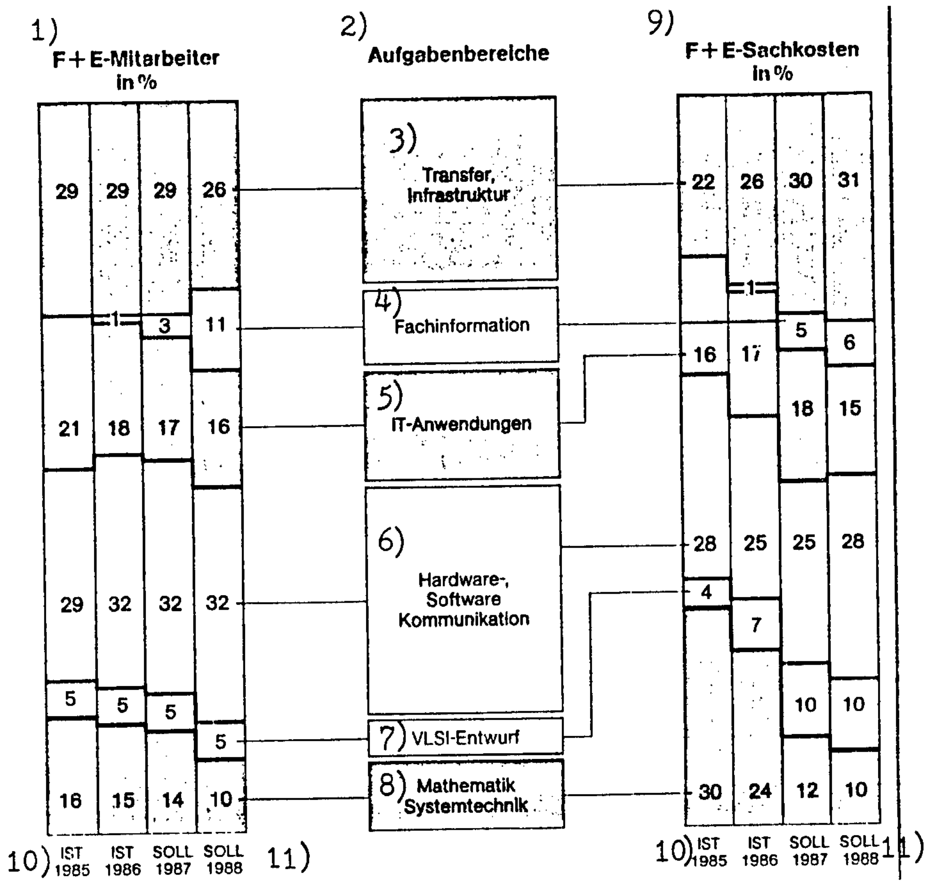
**4.2.7 GMD [Society for Mathematics and Data Processing mbH]**

Schloss Birlinghoven, 5205 St. Augustin 1
Telephone: (0 22 41) 14-1; Telex: 8 89 469 (gmd d)

Research and development as well as training and additional training in the field of information technology, in particular computer science, as well as in the area of technical information and the fields of mathematics of special significance to progress in information technology.

Availability of subsidiary computer and communications capacities for use by the societies.)t∫

| | Outlay in million DM | | | Total personnel | | |
|---|---|---|---|---|---|---|
| Funding | Actual 1985 | Actual 1986 | Est.1987 | Actual 1985 | Actual 1986 | Actual 6-30-87 |
| Federal Government (90%) | 73.2 | 87.4 | 87.7 | 552 | 552 | 552 |
| North Rhine Westphalia and Hessen (10%) | | | | | | |




Key:—1.R&D employees in percent—2.Research areas—3.Transfer, infrastructure—4.Technical information—5.IT applications—6.Hardware, software communication—7.VLSI design—8.Mathematics and systems technology—9.R&D material costs in percent—10.Actual figure—11.Estimated figure

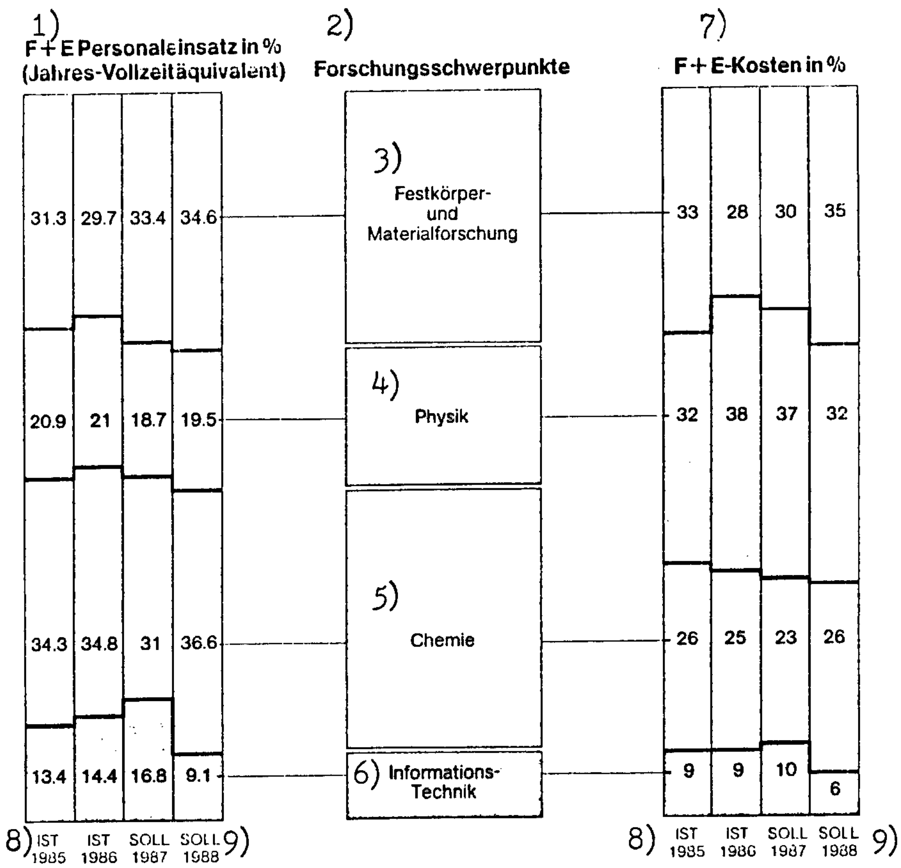
### 4.2.10 HMI [Hahn-Meitner Institute Berlin GmbH]

Glienicker Strasse 100, 1000 Berlin 39

Telephone: (0 30) 80 09-1; Telex: 1 85 763 (hmi d)

Research in the areas of solid state physics, heavy ion physics, radiation and photochemistry, data processing and electronics. Research opportunities are essentially determined by the availability of various sources of radiation (reactor BER II as a neutron source, heavy ion accelerator VICKSI, electron accelerators ELBENA and LINAC).

| | Outlay in million DM | | | Total personnel | | |
|---|---|---|---|---|---|---|
| Funding | Actual 1985 | Actual 1986 | Est.19871985 | Actual 1986 | Actual 6-30-87 | |
| Federal Government (90%) | 107.9 | 109.3 | 116.8 | 488 | 489.5 | 496 |
| Berlin(10%) | | | | | | |



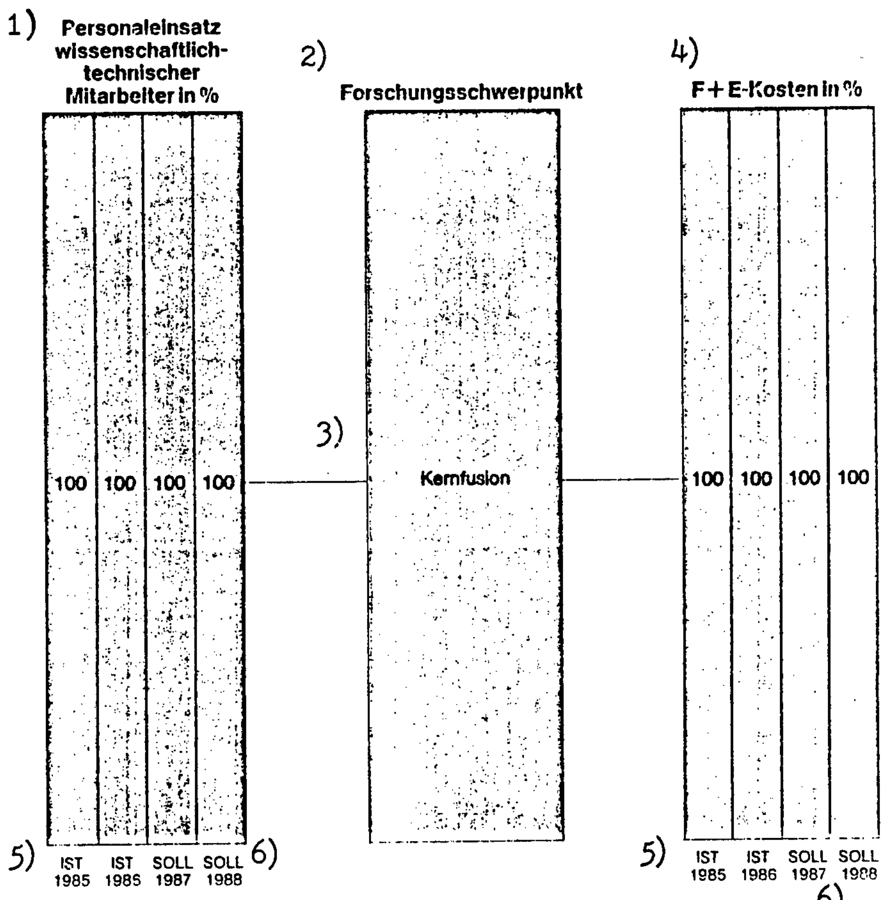

Key:—1.R&D personnel input in percent (annual full-time equivalent)—2.Research concentrations—3.Solid state and materials research—4.Physics—5.Chemistry—6.Information technology—7.R&D costs in percent—8.Actual figure—9.Estimated figure

**4.2.11 IPP [Max Planck Institute for Plasma Physics]**

8046 Garching bei Muenchen
Telephone: (0 89) 32 99-1; Telex: 5 215 808 (ipp d)

Experimental plasma physics, production, heating and confinement of plasmas, surface physics

| | Outlay in million DM | | | Total personnel | | |
|---|---|---|---|---|---|---|
| Funding | Actual 1985 | Actual 1986 | Est.1987 | Actual 1985 | Actual 1986 | Actual 6-30-87 |
| Federal Government (90%) | 151.9 | 165.2 | 159.3 | 921 | 912 | 898 |
| Bavaria (10%) | | | | | | |



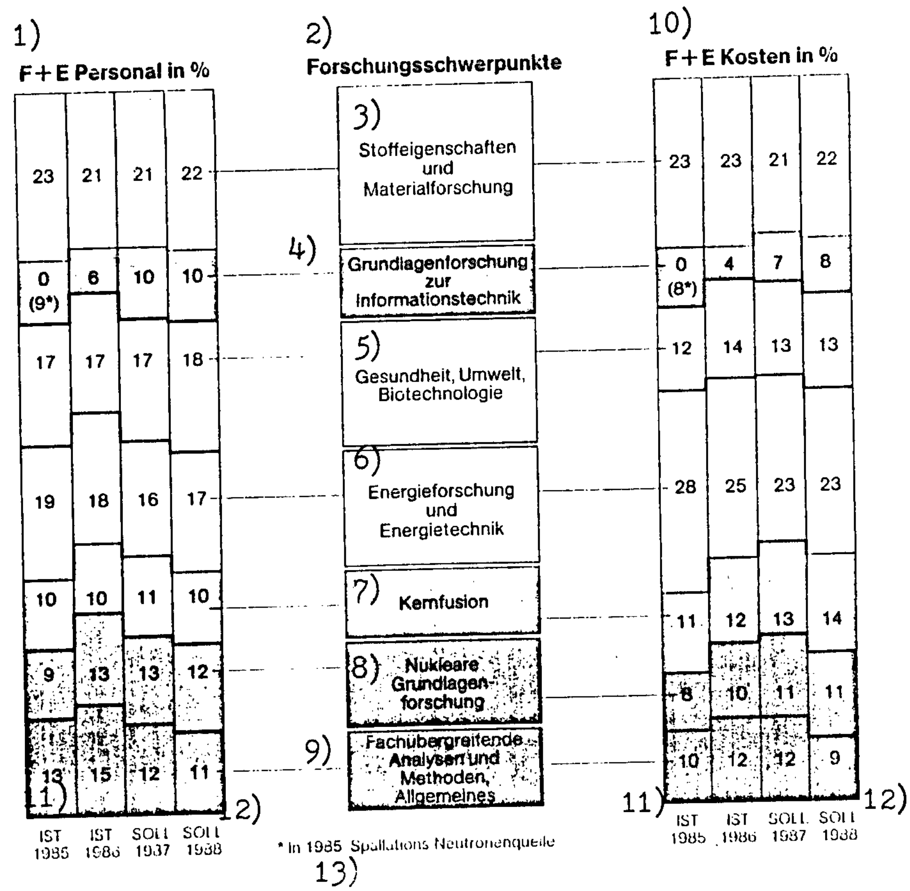

Key:—1.Personnel input of scientific and technical employees in percent—2.Research concentration—3.Nuclear fusion—4.R&D costs in percent—5.Actual figure—6.Estimated figure

**4.2.12 KFA [Juelich Nuclear Research Facility GmbH]**

Postfach 19 13, 5170 Juelich 1
Telephone: (0 24 61) 61-0; Telex: 8 33 556 (kfa d)

Research work on high-temperature reactors, solid state physics, new materials, information technology; basic nuclear research; life sciences; environmental research; fusion research.

| | Outlay in million DM | | | Total personnel | | |
|---|---|---|---|---|---|---|
| Funding | Actual 1985 | Actual 1986 | Est.1987 | Actual 1985 | Actual 1986 | Actual 6-30-87 |
| Federal Government (90%) | 475.9 | 463.0 | 504.4 | 3,375 | 3,316 | 3,303 |
| Baden-Wuerttemberg (10%) | | | | | | |




Key:—1.R&D personnel in percent—2.Research concentrations—3.Material properties and materials research—4.Basic research for information technology—5.Health, environment, biotechnology—6.Energy research and energy technology—7.Nuclear fusion—8.Basic nuclear research—9.Interdisciplinary analyses and methods, general—10.R&D costs in percent—11.Actual figure—12.Estimated figure—13.In 1985: Spallation neutron source

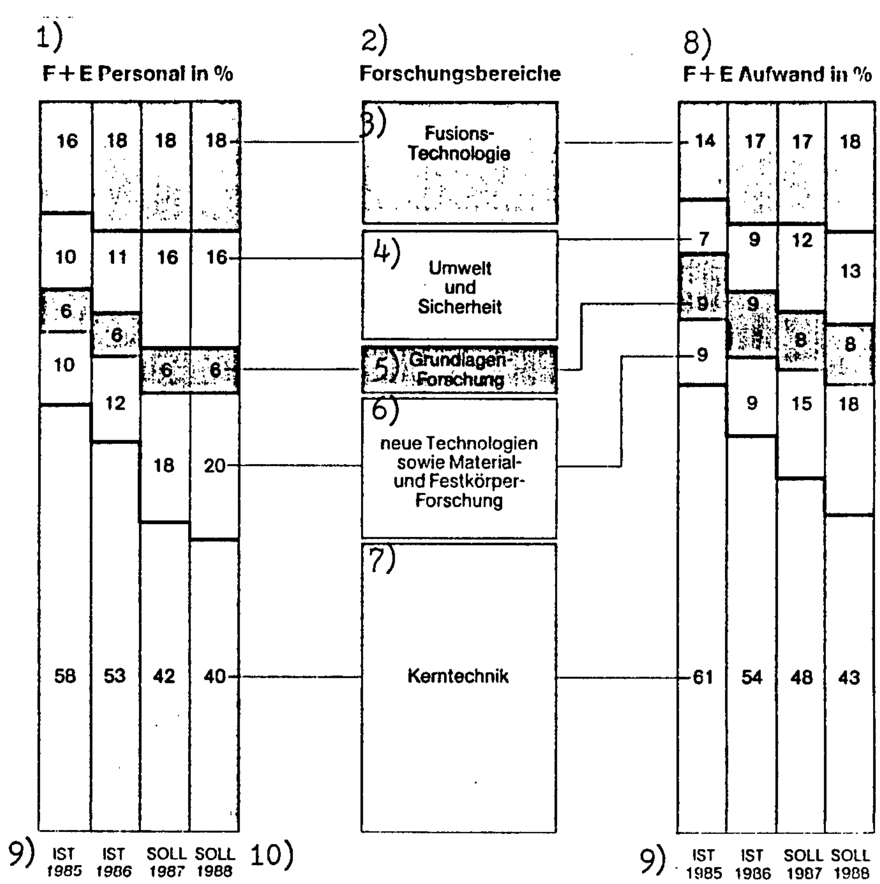
### 4.2.13 KfK [Karlsruhe Nuclear Research Center GmbH]

Postfach 36 40, 7500 Karlsruhe 1
Telephone: (0 72 47) 82-1; Telex: 7 82 648 (kfk d)

Research work on fast breeders and on the nozzle enrichment process; nuclear fusion; reprocessing and waste management; permanent storage; Technology-Man-Environment Project; solid state and materials research; nuclear and particle physics; microtechnology; handling technology.

| | Outlay in million DM | | | Total personnel | | |
|---|---|---|---|---|---|---|
| Funding | Actual 1985 | Actual 1986 | Est.1987 | Actual 1985 | Actual 1986 | Actual 6-30-87 |
| Federal Government (90%) | 603.7 | 614.3 | 638.2 | 3,174 | 3,146 | 3,093 |
| Baden-Wuerttemberg (10%) | | | | | | |

11949




Key:—1.R&D personnel in percent—2.Research concentrations—3.Fusion technology—4.Environment and safety—5.Basic research—6.New technologies, as well as materials and solid state research—7.Nuclear technology—8.R&D spending in percent—9.Actual figure—10.Estimated figure

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